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DEPARTMENT OF ENERGY'S NUCLEAR WEAPONS LABORATORIES

HEARING

BEFORE THE

SUBCOMMITTEE ON
DEFENSE INDUSTRY AND TECHNOLOGY

OF THE

COMMITTEE ON ARMED SERVICES
UNITED STATES SENATE

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CONTENTS

CHRONOLOGICAL LIST OF WITNESSES

	Page
Hecker, Dr. Siegfried S., Director, Los Alamos National Laboratory	9
Welber, Irwin, president of Sandia National Laboratories	37
Davis, Dr. James I., Executive Officer of Lawrence Livermore National Laboratory	41
Yonas, Dr. Gerold, president, Titan Technologies	78
Cramer, Dr. James, chairman, Science and Engineering Associates	82
Lattman, Dr. Laurence, president, New Mexico Institute of Mining and Technology	85
Murphy, Joellyn, vice president, Public Service Co. of New Mexico	88

DEPARTMENT OF ENERGY'S NUCLEAR WEAPONS LABORATORIES

SATURDAY, NOVEMBER 7, 1987

U.S. SENATE,
COMMITTEE ON ARMED SERVICES,
SUBCOMMITTEE ON DEFENSE INDUSTRY AND TECHNOLOGY,
Albuquerque, NM.

The subcommittee met, pursuant to notice, at 1:30 p.m. in the City Council Chambers, City Hall Building, Fifth and Marquette, Senator Jeff Bingaman (chairman) presiding.

Present: Senators Bingaman, Glenn and Domenici.

Staff present: Gerald K. Bankus, professional staff member; and Pamela G. Powell, staff assistant.

Also present: Edward McGaffigan, Jr., assistant to Senator Bingaman.

OPENING STATEMENT OF SENATOR JEFF BINGAMAN

Senator BINGAMAN. I want to thank everybody for coming, particularly Senator Glenn and Senator Domenici for being here today for this hearing, and all the witnesses.

We are gathered for what I believe is one of our more important field hearings in the Armed Services Committee. The Subcommittee on Defense Industry and Technology is going to hear testimony today on the future of the Department of Energy's Weapons Laboratories.

This is at a particularly crucial time, I believe, when we have a variety of factors coming together which put significant stress on the laboratories' budgets. I am sure my colleagues will refer to some of those factors.

I am pleased that from the Armed Services Committee of the Senate, where I serve, Senator John Glenn from Ohio is here.

I am also very pleased that Senator Pete Domenici, my senior colleague from New Mexico, who is the ranking minority member on the Research and Development Subcommittee of the Senate Energy Committee is here.

I think all three of us have a deep interest in the laboratories, which we regard as cornerstones of our defense technology base and as engines for economic growth, whose potential has probably not been adequately tapped.

Today we have two panels of witnesses. The first panel will consist of representatives from the laboratories. They are at the table right now. I will introduce them in a few minutes.

The second panel will include four individuals from the private sector, who will comment from their own perspectives on the appropriate roles of the laboratories.

Before I turn to my colleagues for statements that they might want to make, let me just make a few comments about the situation facing the laboratories today.

The core mission of the three laboratories has been the development of nuclear weapons, and as long as the Nation relies on nuclear weapons as its deterrent, that will continue to be their core mission.

That mission, I believe, is no longer the source of growth at the laboratories. The number of employees at the laboratories who work on that mission has been declining for a couple of years.

The main reason is that the requirement for new types of nuclear weapons has also declined. Thus far, a declining requirement has largely been the result of choices made within the Pentagon regarding nuclear versus conventional weapons development, for instance, the emphasis on a non-nuclear SDI. Mutual and verifiable arms control agreements with the Soviets, something which I am sure we all desire, could further reduce new nuclear weapons requirements and thus the laboratories' core mission.

But there are also tremendous pressures on the core weapons research budget of the laboratories because of the urgent requirements to deal with the growing problems in the Department of Energy's weapons production complex. Much of that production complex is over 30 years old and well beyond its design life.

We have heard testimony in recent weeks from senior DOE officials before the Armed Services Committee and the Energy Committee as well, that the decommissioning of old facilities and building, the needed new facilities in that complex could well cost upwards of $100 billion over the next decade.

If the resources for this core mission of the laboratories decline, the issue then is where can and should the laboratories best contribute to the Nation's needs in addition to that core mission. How can they do this and what impacts will further diversification of the labs have on their character?

These are the kinds of questions we are going to explore today.

In the early seventies, when the weapons laboratories last faced a significant decline in their core mission, the Nation was confronted by an energy crisis and turned to the weapons laboratories and other DOE national laboratories to address that very crucial issue.

That funding for basic energy research, including nuclear, solar geothermal, and magnetic fusion in the seventies kept the laboratories at the cutting edge of our Nation's needs there.

Unfortunately, in the eighties, with the decline in world oil prices, which we all know will be short term and will inevitably end sometime in the 1990's, funding for energy research has declined.

Many of us in Congress believe we should have been doing more to address our long-term energy problem and our growing dependence on foreign energy resources, but it appears that another energy crisis will be required in order to shake us out of the complacence we seem to have on this subject.

Thus, it does not appear that this is an area for laboratory expansion in the very near term.

In the 1980's the main diversification of the laboratories' mission has been in the area of non-nuclear defense programs. This has been the main source of employment growth of the laboratories.

The laboratories have become deeply involved in the development of laser and particle beam devices as part of the Strategic Defense Initiative. They have been involved in advanced conventional munitions research and the Defense Advance Research Projects Agency's armor, anti-armor initiative and several other programs.

Encouragement for the labs to play a broader role in the non-nuclear defense programs has come from a variety of sources, most notably the President's Blue Ribbon Task Force on Nuclear Weapons Program Management, which was chaired by Judge William Clark in 1985.

The Senate Armed Services Committee has supported the diversification because I believe we all recognize the enormous potential of the DOE Weapons Labs to contribute to Department of Defense needs.

We face serious problems in productivity in many of our Department of Defense laboratories, as distinguished from our Department of Energy laboratories. Those Department of Defense laboratories simply do not have the personnel or facilities to match DOE laboratory capabilities. If we had to do it over again, perhaps we would re-think the question of whether those DOD laboratories should be government operated or contractor operated. We do not have that choice, but we can help DOD laboratories by forging a closer working relationship between the DOE and DOD laboratories.

The Senate Armed Services Committee has also encouraged laboratories to increase their efforts in verification and surveillance technologies.

This year, at my initiative, the committee added $25 million to the Department of Energy's request for verification research because we were concerned that the proposed budget level was inadequate for timely development of verification technologies needed by our arms control negotiators.

Finally, let me just say that today's analogy to the 1970's energy crisis is the trade and competitiveness crisis that the country faces at this point.

We have an annual trade deficit approaching $170 billion, and we have become the world's largest debtor nation, and facing up to that crisis is going to require government and industry to come up with new modes of collaboration.

Senator Glenn has been very instrumental in bringing the machine tool industry together to establish a national center for manufacturing sciences which, unfortunately, from Senator Glenn's perspective, is located in Michigan and not in Ohio.

Senator Domenici and I have both been working with the semiconductor industry on their manufacturing technology consortium, SEMATECH. We have been attempting to define the proper Federal role in that project, especially the roles of the Department of Defense and the Department of Energy national laboratories.

Senator Domenici and I have also similarly worked on the DOD and DOE roles in responding to the break-throughs in high temperature superconductivity research.

The opportunity for DOE's laboratories appears to lie primarily in the areas of large-scale high-risk, multi-disciplinary research projects that are too long term and too risky for industry to undertake, and also too large and interdisciplinary for universities.

It is going to be vital for the laboratories in these areas to forge close working relationships with the private sector, including our universities.

We are going to have to improve the technology transfer process. We need to remove the existing impediments to technology transfer if labs are going to become the engines for economic growth for this Nation in general and in the case of Los Alamos, and Sandia, for New Mexico, in particular.

The enormous cloud overhanging the whole discussion today is the Federal budget deficit crisis. I am sure my colleague, Senator Domenici, who has been involved in the negotiations with the administration on this issue, will discuss that.

But the focus of today's hearing will be on what the laboratories can and should be doing to further diversify their efforts to better work with the private sector in such areas as energy, non-nuclear defense, and semi-conductor manufacturing.

Regardless of how the budget negotiations turn out, I think we can expect there will continue to be tight restraints on Federal defense and non-defense discretionary spending in the years ahead.

That is the environment for which the laboratory directors have been trying to prepare. Before I turn to the lab directors for their testimony, I would like to call on Senator Glenn and then Senator Domenici to make any statement they would like.

Senator Glenn, we welcome you to New Mexico.

Senator GLENN. Thank you, Jeff. Thank you very much. I am glad to be here.

I agree with the chairman that today's hearing is of vital importance as it is an important issue. Although I am from Ohio, I have had a long and a very deep interest in the three laboratories represented here today. I have tried very hard to visit them on a yearly basis to keep up with what was going on, the status of the labs and what kind of support they need from Washington.

The U.S. laboratories system is basically the best system of its kind and it is the envy of the world. Most other nations do not have the dozen or so national labs that we have around the country, with their specialty areas. These labs are a unique national resource and we need to learn how to better take advantage of that resource to serve our Nation's broader needs.

Research should not be all tied up in defense with all the emphasis there. We need to diversify and broaden out. We need to be careful, though, in how we go about that diversification process.

There needs to be synergy between the laboratories' efforts and those of the private sector, including our universities.

If I could depart just one moment here, there are two very basic things I think made this country what it is. No. 1 is the educational system we set up in this country. Education here came to be not just for kids in the castle or the politically connected or the economically rich. Education in this country came to be for everyone, and out of that came an educated citizenry.

Then, No. 2, and of more importance to us for today's consideration, we poured more of our gross national product back into basic, fundamental, seminal, break-through type research than any nation in history.

Then we have the people to create the business, the jobs, the whole employment patterns that just leapfrogged us ahead of the rest of the world.

Lots of places in the world had fruited plains and purple mountain majesties and rivers flowing to the sea we like to sing about, but they did not develop the way we did because they did not have the same education of all their people and they did not have the same basic research that we have.

Much of that basic research has come from the Government. I know the President is fond of saying that if it is worth doing, private industry will do it, but I disagree with that.

I did not come here for political speeches today, but I disagree strongly with it, because a large segment of the basic breakthrough in this country has been through the Government laboratories system.

We have some companies, IBM, Bell Labs, 3M and Monsanto, and others that do the 5 to 10 to 15-year research projects, but by and large that is not the pattern in industry these days.

Any CEO that does not produce a big bottom line surplus within 3 to 5 years is out, so it is difficult to commit to the 10 or 15-year programs. That is what the Government labs do, and so that involves the educational area in our universities.

So I think there is great promise for laboratory contributions in the areas that the chairman has mentioned. I have taken a keen interest in trying to expand the verification research progress of the laboratories.

It is clear to me that verification is central to any of our arms control negotiations, and I think it would be fair to say that verification technologies and strategies have just not kept up with weapons technologies.

We need to do a better job in that area and the labs can certainly help.

The same is true in the area of advance conventional munitions, where Senator Bingaman and Senator Nunn have taken a leading role in implementing the recommendations of that 1985 Blue Ribbon Task Group headed by Judge Clark.

A couple of years ago, when I visited Los Alamos with Senator Bingaman, for instance, they locked us up in a block house and demonstrated some extraordinary anti-armor projectiles they had developed. We observed from the block house. They were not shooting at us in the block house. [Laughter.]

We also talked about a variety of other conventional weapons programs, the details of which we will not be able to discuss today in open session, but it is clear to me we need to take greater advantage of the laboratories' capabilities to help our conventional defense programs. That is most important.

The farther down the nuclear disarmament track we go, the more important the conventional balance becomes.

So I look forward to hearing the witnesses today discuss the role of the laboratories in improving our nation's competitiveness in key high technology industries.

Jeff Bingaman and I worked together on the Governmental Affairs Committee, and earlier this year I had an idea to create a civilian Defense Advanced Research Projects Agency, make a civilian counterpart to that within the Commerce Department to fund exploratory development of critical civilian technologies that were too high risk and too long term for industry to undertake.

We foresaw a significant role for the national laboratories in that effort as one place where industrial consortia could come together with government to conduct research.

Unfortunately, the Advanced Civilian Technology Agency, the official title of what I was proposing, proved to be what I think is ahead of its time and was dropped from the Senate Trade bill in July, but I remain convinced that something like it is vitally needed and will be reinvented in the future.

Let me conclude by commending Senator Bingaman for holding this important hearing today. He is a leader on the Armed Services Committee in addressing the long-term underpinnings of our national security, namely, our technology and our industrial basis.

He is a leader in the Governmental Affairs Committee in addressing our Nation's long-term strategy to remain competitive in world markets.

That is important to us in Ohio, as well as New Mexico. About one-sixth of our work force makes products that have to be exported to keep those people working. So it is important to us also.

Let me also say that New Mexico, I feel, is lucky to have two Senators who take such a deep interest in research and high technology.

This research is the life blood of this State. Per capita research spending in New Mexico is, I believe, seven times higher than in any other State in the Nation. I am flat jealous of that figure, coming from Ohio.

I know from my experience in the Senate that your Senators do work well together to address both the military and civilian research needs of this Nation. I want to compliment both of them today, and I am very glad to be here to participate. I look forward to hearing the witnesses.

Senator BINGAMAN. Pete.

Senator DOMENICI. Thank you very much, Mr. Chairman.

First, Senator Glenn, may I also welcome you to our State. Obviously, it isn't your first visit, but we welcome you any time.

Let me see if I can briefly express my views to this subcommittee. In one respect my ideas are similar to the two of yours, but perhaps they are slightly different in another respect.

There is not any question but that the three national laboratories, the so-called nuclear laboratories, that are going to be testifying here today, two from our State of New Mexico and one from California, have a tremendous and proud history. They have been very successful. If they had not, we wouldn't be meeting here today.

In a sense, they have had one of the most technically complex missions in all of mankind's history, that of maintaining America's nuclear deterrent. In another sense this mission was made easier because of its importance and the sense of urgency that inspired.

They have not been parochial. They have not been regional. They were the nuclear deterrent for all of America. They put together whatever resources were necessary to execute their responsibilities. They put together whatever technology and science they needed to do their assigned jobs.

I think all Americans would agree that these laboratories responded to the challenge and all did their job magnificently.

The truth of the matter is whether we have a treaty with the Soviet Union or not, for the foreseeable future we just as well put reality on the table. The defense build-up is over. The defense build-up lasted for 4 years, but it is now over.

If you ask a crowd of 100 people, informed people, what has happened to the defense budget for the last 4 years, about 70 will put up their hand to indicate it has increased a lot. If you ask has it gone up slightly, almost all the rest will put up their hands. If you say, how does it strike you that the program authority for defense has been about frozen for the last 3 years, then normally, Jeff, we would not get a response. People don't know this.

But that is the true fact, however. The budget authority for defense programs, and that is what drives the programs, is lower today than 4 years ago.

Now, I just put that out on the table because it seems to me that it is good to talk about some alternative missions for these magnificent laboratories of the Department of Energy.

Senator Glenn has just indicated that the Clark Commission said we sure ought to do that. If our Nation already has the talent and expertise gathered together in these laboratories and we still have research and development efforts remaining in non-nuclear areas, then we ought to not create another institution, we ought to use these talented laboratories.

If we have additional jobs to do in the weapons field, and there will be jobs to do for 20 years or more, the laboratories will be able to continue to handle these responsibilities. Taking on a new mission doesn't require them to foul up their present core mission.

But I believe the real issue is none of those. I think the real issue is whether the U.S. Department of Energy can find a way to literally change the culture of the national laboratories with reference to who they do business with and how they do business. In essence, we want the DOE to help them become user friendly.

Do we want to let them begin to use their scientific and technological prowess for customers other than the Federal Government? To do so will help our country maximize its technology prowess. Ultimately the marketplace and trade will be enhanced by the labs assisting industry to produce scientific goods, technology goods, and break-through goods for the American marketplace.

I believe that this is the most significant challenge facing America. I believe the labs have demonstrated their scientific prowess and it is everything that Senator Glenn said. They have indeed had a great past.

But we have seemed to miss the integration of universities, national laboratories and private sector research and development. I regret to tell you, as one Senator, it is my opinion that it has been a luxury to have these institutions work separated from one another. This is a luxury that is stupid, it is a luxury that wastes valuable resources, and it is a luxury that must cease.

Now, having said that, it is not easy to change that culture of separatism and make all three of these institutions work together in areas of common interest.

I am finding, since May of this year, at least, when I asked 25 of the best from universities, industry and national laboratories to sit a day with me and tell me about their perception of this issue that a cultural change is necessary.

User friendliness on the part of the labs is absolutely mandatory, and I have introduced a few bills that direct attention of the labs to specific areas of technical work and tech transfer.

In the process of doing that, I am not critical of the labs. They are not independent entities. They work for the Federal Government.

I am not today totally critical of the Secretary of Energy. I am only partial critical of him. [Laughter.]

He is beginning to see the light. He is the manager of the largest scientific base in America and he ought to act like it and he ought to use it to help our country in many areas. It is a much bigger scientific base than the Department of Defense owns.

It is by far bigger than any private laboratory consortium. In the past, the labs have been niched to their prime mission and not given any independence. The Department of Energy has been scared to death to let them work for the private sector.

Most of the reasons for the DOE's reluctance to do this have been military secrets related to nuclear research. That is all marvelous, but in exercising that, they have been far too rigid on these labs.

I believe the time has come to, either by administrative fiat or by congressional language, turn these laboratories loose at the local level and give them more autonomy to get involved with the private sector. We are working on that.

Let me suggest that the Secretary of Energy is making some headway on superconductivity. He held a national conference and then he designated Los Alamos to put together a pilot program for the national laboratories to involve the private sector and academia.

I hope Sig reports on the events of that day. I understand it has been an experience for him and his laboratory, and hopefully for a number of private sector companies. It will be tough sledding in the future because it is really a cultural change.

Second, we have to find a better way to use the laboratories to enhance our university capacities, and we have to use our universities to enhance our laboratory capacities. I want to see a positive synergism develop.

Frankly, I will be parochial, Senator Glenn, and I regret doing so, but I think Senator Bingaman will agree wholeheartedly, we have an enormous problem in New Mexico in that while we have all of these scientists you spoke of, and all of this scientific research, we have not found a way to create major centers of scientific excellence in our universities while excellence is everywhere in the laboratories.

Now, I think that is our challenge, but in a sense it is a microcosm of the country's problems. There is no good use served by having universities and laboratories of America working in isolation. Our need for developing more products that better compete in the international market place means that universities and national laboratories must work hand-in-hand.

Some of these issues are being addressed in current bills. Some of them are treated in the defense bill, some of them in the energy bill, that I introduced and Jeff is helping me with, and many others, but they are directives in either superconducting or semiconductor work or genome research.

I have been unable to find some generic way to accomplish this interface of industry, universities and national laboratories, so we focused on special areas.

So I think we have to keep exploring the issue, and we have to keep pushing. We have to sooner or later decide whether we really want these national labs run essentially by the Department of Energy, to be committed to working for the Government, and single mission focused or do we want to find ways to encourage them to get involved in the marketplace with the private sector and in research with the universities.

I believe the labs' future, New Mexico's future. and the country's future depends on this happening. I am equally convinced that the country will come out second best in applied technology development if we don't better utilize the national laboratories.

So this is a very important set of hearings. There will be many more, and we will be many years getting there. To change cultures is not easy. The Japanese did not have these problems. They married universities, government, industry, and business. They took their best labs, their biggest banks, and their best businesses, put them together, and told them to work together. Their officials just said do it, and the people did it.

So if we are going to play catch-up in international technology trade, we better make sure we use all the best tools we have available.

Thank you very much, Mr. Chairman.

Senator BINGAMAN. Thank you very much.

Now we will hear from the directors of the labs. Our first witness is going to be Dr. Sig Hecker, Director of Los Alamos since January 1986. Sig came to this current position after a distinguished career both at Los Alamos and at General Motors as a materials scientist.

We have discussed these issues many times with you, and we are anxious to do so again today.

STATEMENT OF DR. SIEGFRIED S. HECKER, DIRECTOR, LOS ALAMOS NATIONAL LABORATORY

Dr. HECKER. Thank you, Mr. Chairman, Senators Glenn and Domenici, thank you for the opportunity to let me present my views on the future of the laboratory and the weapons laboratories in general.

I think this is an opportune time, as you say, to examine the future of the laboratories in the light of the changing requirements for nuclear weapons.

In addition, I think we must also, though, to assess the long-term consequences of any of the immediate budgetary actions, be they the Gramm-Rudman sequester or a compromise worked out by the Congress and the President.

Now, you have given such a fine introduction to the issues on the table today. What I would like to do is to make sure to leave you with three key messages today, and that is, first of all, the core mission, Mr. Chairman, that you discussed, of supporting nuclear deterrents, will require strong support from Congress and from the executive branch even in a world with fewer nuclear weapons; that is, a nation cannot allow nuclear competence to erode.

Second, I believe the message that we have already diversified substantially into non-nuclear defense and non-defense research and technology, that we will continue to do so.

It does permit our laboratory to serve the role of a true national laboratory, national with a capital N, and at the same time it also enhances our primary mission.

Third, the diversification in the present format has brought about a change in how we do business. I think this, in conjunction with ever increasing administrative requirements and government regulations that are imposed on research institutions, is undermining the basic strengths that have contributed to the excellence of the laboratory.

So I will try to give you a brief glimpse of our programs and future directions, and with your permission I will submit a more detailed statement for the record.

Senator BINGAMAN. That is fine. We will be glad to include that in the record.

Dr. HECKER. Let me start first with a few facts about the laboratory. I think all of you know the laboratory was established during World War II to develop the atomic bomb to end World War II.

We have grown into a large and multi-program laboratory since that time. We are operated by the University of California for the Department of Energy. We currently employ approximately 8,000 full-time equivalent, professional and support staff.

We have an annual operating budget of $850 million with another $100 million in capital equipment and construction.

I might add that we have an enormous economic impact of approximately $2 billion in New Mexico. And in the tri-county areas of Santa Fe, Rio Arriba, and Los Alamos, the Los Alamos National Laboratory accounts for approximately 38 percent of the jobs, either directly or indirectly.

As you mentioned, the primary mission today is nuclear weapons technology, and that is sponsored by the Department of Energy. That comprises about 53 percent of our total funding.

This includes not only the design of nuclear weapons but as you all recognize, we also have the responsibility for their safety, security, for production oversight, for surveillance and for the retirement of those nuclear weapons.

Along with that, we also work to enhance the verification capabilities, safeguards, security and processing of nuclear materials, as well as nuclear intelligence.

As you have already mentioned, we also conduct non-nuclear defense work for the Department of Defense, and that today comprises approximately one-quarter of the laboratory's activities. The remaining 22 percent is in the area of non-defense research and technology that we do for the Department of Energy and other sponsors.

Now, at Los Alamos we have been able to advance the frontiers of science and develop technologies with applications for both the defense and the civilian sectors.

We have stayed in very close touch with universities, and indeed that has been one of the measures of our success, of keeping in close touch with the academic world.

We have combined individual scientific creativity with teamwork and engineering, to be able to conduct large, complex technology projects.

As we look at the future, I think that one important thing to do is to look at the past and ask what has made us successful, and I think we clearly have to recognize that it is the strong primary mission of nuclear weapons technology which has had an unquestioned national importance that has made us strong.

It has provided the solid and the stable funding support that has allowed us to explore the limits of science and maintain an exceptional basic research base that keeps us poised for new technology developments in the future.

We have also enjoyed the privilege of being operated by the University of California, which has provided us with a sense of academic freedom and scientific excellence. It has also been able to expedite many of the usual Federal administrative requirements that beset organizations such as ourselves.

I think this arrangement all the way around has served the Nation well.

Let me spend a few minutes on nuclear weapons, technology, and let me explain why I urge you to continue your strong support of the nuclear weapons technology program even though, as Senator Domenici has said, our defense build-up is certainly over for the time being.

Along with you, we all look forward to the December 7 summit between President Reagan and General Secretary Gorbachev and hope that the pending agreement on short-range and intermediate-range nuclear forces in Europe will pave the way for meaningful strategic arms reductions as well.

However, because of the current imbalance in conventional military power, we still will need to rely on nuclear deterrents for the foreseeable future.

Also, as you all recognize, we cannot put the nuclear genie back into the bottle, and so we will never be able to ignore nuclear weapons in our national security strategy.

I believe that the DOE nuclear weapons laboratories face even greater responsibility and challenges in a world with fewer nuclear weapons, and that is we will still have the statutory responsibility to provide nuclear weapons technology to assure the deterrent, and with fewer weapons, those that remain will be more important.

Their military characteristics and reliability will be especially critical to preserving the strategic stability, and nuclear competence, which relies heavily on our ability to do underground nuclear testing.

So we feel that a careful build-down of weapons must take into account the vastly different force structures of the super powers and the continually changing targets base of the Soviet Union.

This will undoubtedly require modernization of our current nuclear force structure to preserve that global stability, especially since some of the current nuclear weapons systems in stockpile have been there for over 30 years.

Modernization, however, will continue to mean different and fewer systems and not more weapons. In fact, it is important to note that is a fact that few people recognize that over the past two or so decades the United States has reduced the number of nuclear weapons by about 25 percent and the total yield actually by a factor of four.

So in a world with significantly fewer weapons, we will still need to preserve that nuclear confidence, and we can make a great contribution in areas such as verification technology.

So the point that I want to make is that nuclear deterrence is complex and nuclear confidence is imperative, and healthy weapons laboratories are a key to both of these. They provided the Nation with the critical capacity to be able to respond to the dynamics of world politics and technical change.

Senator Bingaman, as you have already pointed out, in the past couple of years the employment levels in our nuclear weapons technology programs have indeed slipped. They continue to slip this year, even before the considerations of Gramm-Rudman sequesters.

Now, let me turn to the broader defense role, and as you have already mentioned, the broad science and technology base that we have been able to develop at these national laboratories has served us well in areas of conventional munition and nonnuclear defense.

In fact, we were able to respond rapidly to the President's Strategic Defense Initiative by expanding already existing research in areas such as particle beam, lasers, computational science and system analysis.

We are leading an effort, as you mentioned, with industry to develop new armor, anti-armor technology for the joint Army and Marine Corps program.

We also have numerous small projects that are aimed at solving specific problems for the services. Now, many of these are conducted in what I would call the contractor type mode. They tend to be very management and paperwork intensive, and that does not necessarily take best advantage of the capabilities of the laboratory.

Our current DOD projects, which, as I mentioned earlier, comprise about 25 percent of the budget, lack a stable funding base and strong institutional commitments.

The nonnuclear defense work, however, is scientifically and technically extremely challenging, and under the proper funding and institutional arrangements, the weapons laboratories could have an enormous national impact.

Just to give you a few examples of the type of capabilities that we have built up that are very pertinent to the nonnuclear defense activities, these include expertise in areas such as explosives, advance materials, computational sciences, information processing, diagnostics, accelerators, high-powered lasers and pulse power.

In fact, if we sit back for just a minute and think about the battlefield of the future, we can see that large scale, real time information processing is going to be crucial to conventional war fighting capability.

This is an area where our tradition as one of the world's leading computational centers and our current research in large scale computations, massively paralleled processing, computer networking and ultra high speed graphics can provide the military with the next generation of capability.

Similarly, we can contribute in a number of other areas, such as advanced sensors, submarine communication, microwave munitions, and so forth.

So we believe that a broader defense role for the nuclear weapons laboratories should be actively supported, and we believe that Congress, the agencies, namely DOE and DOD, and the laboratory should develop policies and institutional relationships that will encourage that laboratories to contribute long-term science in the spirit of a first-rate scientific institution that has a defense mindset.

We think that way we could compliment the university's research base and the practical and product orientation of the DOD laboratories and the private sector.

Let me turn next to the vital non-defense role, and that is research and development in non-defense areas vital to the scientific excellence of a defense oriented laboratory. And of course, that also means that we have the unique capabilities to contribute to our Nation's well-being and economic strength.

Our contributions to basic research and contributions to energy technologies, both nuclear and non-nuclear, have been outstanding.

We are now also contributing in the areas of health and environmental research, and as mentioned earlier, we are exploring ways to try to help the Nation in the problem of economic competitiveness through technology transfer.

Now, we are actually proud of the accomplishments in the technology transfer arena. Approximately 25 businesses have been established over the past 5 years as spin-offs from our laboratory.

We have also had a major stimulus on the Nation's supercomputer industry, that is our work with IBM and CRA in the early years led to the first generation of supercomputers, and the labs continue to provide a very strong technology pull to this industry.

There are other examples, but as both of our Senators from New Mexico have pointed out repeatedly, we in the national laboratories could do much more to help in economic development.

However, this approach will indeed take, Senator Domenici, as you have put it, a change in culture. It will also take the formation of new alliances, and I have outlined in previous congressional testimony, including on Senate bill 1480, such a new venture for the laboratory to form industry-national laboratory partnerships to exploit the scientific break-throughs in high-temperature superconductivity.

We also need to incorporate the Nation's universities into such new ventures, and we are exploring such initiatives with the new national science foundation initiative on science and technology centers.

Such new ventures will require the laboratory to solicit early input and participation from the private sector. It will also require that the laboratories will become more user friendly, as you have put it, Senator Domenici.

It is extremely important that we do change the overall aspects of contracting of intellectual property rights and general access of industry to the laboratories.

Now, what is encouraging, the Secretary of Energy has indeed asked us to explore such new ventures with industry, and we have spent the past few months doing just that.

The initial results are very encouraging in that industrial interest is extremely high, and in fact, we will hear later on in the second panel from one of the companies that we have interacted with very closely, and that is the Public Service Company of New Mexico, where we have asked them to help us identify useful models of interaction between industry and that national laboratories.

I also believe that we need an expanded and newly focused program for energy security in this country, and that is the most effective use of Federal resources to better balance the program between technologies having reasonable near term potential, such as an enhanced oil recovery research and clean coal technology, with those having mid term payoff potential, such as walkaway safe modular neclear reactors, and those with long term potential such as fusion energy.

Along with the DOE national laboratories, such a program must include the research capabilities of our universities and the marketing and business strength of the private sector.

Now, the multidisciplinary strengths of Los Alamos also allow us to contribute on issues of health and environment, as I have already mentioned. In Los Alamos we have initiated what we call the human genome project, which is funded by the Department of Energy and the National Institutes of Health as part of a national effort to understand the human genetic material in a much more fundamental way.

This effort, we hope, will have a profound effect on the impact of human health, including showing the way to treatment of the over 3,000 or so diseases with known genetic causes.

Again, the Department of Energy has just named Los Alamos as one of the two new centers of human genome studies that have contributed strong capabilites to the engineering, biological science and computational aspects of this important problem.

So to summarize the non-defense work I believe the most important thing to say is that we do have the capabilities to contribute in energy, health environment, and economic competitiveness, but we definitely must make the laboratories more user friendly.

Now, let me turn to make a plea for making a friendlier atmosphere for the Federal R&D institutions. I think, as was already pointed out, the Government owned, contractor operated laboratories were established to try to get around much of the government bureaucracy in trying to harness scientific talent to solve goal oriented projects.

In fact, that is the way Los Alamos was set up during World War II, and this system has served us extremely well. We find, however, a significant erosion of these enlightened policies with each passing year, and that as many of the congressionally mandated administrative and regulatory requirements are translated into strict regulations by the executive agencies, these regulations have limited our flexibility, they have limited our discretion in the long term and high risk orientation, which is what has made us a laboratory or excellence to begin with.

I think this is also——

Senator **Domenici**. Mr. Chairman, might I ask a question?

Senator **Bingaman**. Surely.

Senator **Domenici**. I apologize. Could you just repeat the last thought? You turned the page but I did not get it.

Dr. **Hecker**. One of the problems that we face is that we have eroded these enlightened policies of the government-owned, contractor-operated laboratories and in fact, the congressionally mandated regulations which have been interpreted very strictly by the executive agencies have in turn limited our flexibility, our discretion in long-term, high-risk type of research that we do at the laboratories.

Senator **Domenici**. Thank you very much.

Dr. **Hecker**. In addition, the regulatory requirements have also eaten substantially into our operating budgets, and I think into our overall efficiency, and if unabated, the administrative and regulatory requirements will drive the laboratory eventually to a management to avoid all risk, and clearly, that is a terminal affliction for a research and development institution.

In summary, let me then just say that the laboratory has served the Nation well in its principal mission. We have helped to secure peace between the super powers by helping to maintain the deterrent.

The laboratory has evolved into a true national laboratory over the years, serving the Nation in other crucial areas that we have already mentioned, and it is this integration of defense, of non-defense technologies, of basic science and of technology development and these into end applications that represent this true unique resource for the Nation.

The laboratory complements the research and education mission of the universities and the product orientation of private industry.

It concentrates, as we have said, on high risk, high potential payoff research, goal oriented technology on projects that are too big or too complex for universities, too risky or uninviting for private industry, and in the time regime that are not suitable for either.

I think that's the end of my prepared statement.

Senator Bingaman, you had asked us to comment on the specifics of the Gramm-Rudman sequester. I could do so either now or later on.

Senator **Bingaman**. Why don't we take the initial statements of each, and then I am sure we will want to get your thoughts on Gramm-Rudman as we start our questions after that.

Dr. **Hecker**. Thank you.

[The prepared statement of Dr. Siegfried Hecker follows:]

U.S. Senate
Committee on Armed Services
Subcommittee on Defense Industry and Technology

Oversight Hearing on
The Department of Energy's Nuclear Weapons Laboratories

Written Statement by
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LOS ALAMOS NATIONAL LABORATORY: A LOOK AT THE FUTURE

November 7, 1987

I. INTRODUCTION

Los Alamos National Laboratory was established during World War II to develop the atomic bomb that ended the war. The Manhattan Project was an effort of unprecedented proportion and of utmost national urgency. The successful development and production of the atomic bomb marked not only an enormous scientific and technological accomplishment but also the beginning of big, project-oriented government research and development (R&D) laboratories.

The Laboratory's primary mission today remains the development of nuclear weapons technology to maintain this nation's nuclear deterrent. We also share the responsibility for the safety, security, production oversight, surveillance, and retirement of nuclear weapons. We have performed the nuclear weapons responsibilities well and with great pride. We have also become a true multiprogram national laboratory with significant contributions in the nonnuclear defense, energy, health, environment, and basic research areas. This diversification allows us to serve the nation in a more global science and technology role while enhancing our nuclear deterrence role.

The most important reason for our success to date has been the existence of a strong mission of unquestioned national importance. We have advanced the frontiers of science and developed technologies with end applications. We have combined individual scientific creativity with teamwork and engineering to conduct large, complex technology projects. We have built a science and technology base that has allowed us to respond to other national needs while complementing our primary mission.

However, the environment for federally funded R&D institutions continues to change. To a large extent, the fortunes of all the Department of Energy (DOE) multiprogram laboratories are tied to government policies on nuclear energy and nuclear weapons because all were initially established as mission-oriented laboratories focused on nuclear weapons and nuclear energy problems. The decline in public support for commercial nuclear power has had a detrimental effect on most DOE national laboratories. Significant rethinking of missions and priorities of the laboratories has already occurred.

We now also face a decline in appreciation for the continued importance to our national security of nuclear weapons technology and nuclear deterrence. Over the past decade, the buying power of the nuclear weapons R&D budget, our core program, has remained essentially flat. The Laboratory's growth was mostly in Department of Defense (DoD) programs such as the Strategic Defense Initiative (SDI). Now our core program funding is declining. This decline, in conjunction with the national budgetary difficulties, is undermining the strong and stable support that has been the hallmark of the success of our Laboratory.

It is within this context that we ponder the future of the Laboratory (and that of the other nuclear weapons laboratories). How does the nation maintain its nuclear competence in the future? This competence will be at least as important in a world with fewer nuclear weapons as it is today. How do we guard against technological surprise that could seriously undermine our national security? We must maintain our understanding of nuclear weapons technology regardless of the number of warheads in the stockpile.

We should continue to diversify the Laboratory's mission by playing a broader defense role and serving the nation in crucial nondefense areas. This approach would be consistent with new concepts of national security currently evolving, where we recognize the need for stronger conventional forces, consider the possibility of strategic defenses, and recognize that economic strength and military strength are the pillars of long-term national security. We have a proven record of success in energy, health sciences, and basic research. We can make major contributions in mapping the human genome, computational science, and superconductivity. In all these areas, it is essential that technology we develop be transferred to private industry.

Although done carefully with an eye toward strengthening the capabilities of the Laboratory, this diversification has been most difficult. It has been encouraged by Congress and many high-level review panels over the years. Yet diversification is fraught with bureaucracy and regulations that threaten the health and vitality of our institution. Our challenge is to diversify and concurrently protect this nation's nuclear competence while maintaining the vitality of an institution that has served the country well and that continues to do so.

There are three key messages that I would like to leave with you today.

First, our main mission of supporting nuclear deterrence must continue and will require strong support because it is just as important in a world with fewer nuclear weapons as it is today. This nation cannot allow its nuclear competence to erode.

Second, we have already diversified substantially. Diversification is vital to the nuclear weapons mission and, at the same time, allows us to contribute as a true national laboratory in such important areas as energy, conventional weapons, strategic defense, health and environment, computational science, and economic competitiveness.

Third, diversification into areas other than nuclear weapons has also brought with it a significant change in how we do business. This, in conjunction with ever increasing government regulations and administrative bureaucracy, is undermining the basic strengths that have contributed to the excellence of the Laboratory.

I will discuss the programs and directions in nuclear weapons, nonnuclear weapons, and nondefense research and technology. Then I will present my concerns for the future of the Laboratory and recommend some directions.

II. A NATIONAL PERSPECTIVE

The Laboratory is operated by the University of California for the DOE as a government-owned, contractor-operated (GOCO) laboratory. Los Alamos National Laboratory and its sister laboratories, Lawrence Livermore National Laboratory and Sandia National Laboratories, are the nation's three nuclear weapons laboratories. Los Alamos currently employs approximately 8000 full-time equivalent technical and support staff with an operating budget of approximately $850 million, plus an additional $100 million for construction and capital equipment. We occupy an area of 43 square miles in Los Alamos, New Mexico, with 32 technical areas and a replacement value of over $3 billion.

The combined operating, capital, and construction budgets of the three nuclear weapons laboratories exceed $3 billion, which is approximately 5% of the total federal investment in R&D. The laboratories are predominantly defense-oriented (70% to 80% of their effort). Their nondefense activities in research and advanced technologies have helped them remain first-rate scientific institutions that can now serve the nation in the broader context of national security, one that recognizes that national security depends not only on military strength but also on energy security and economic strength.

The United States faces strong competition on both the military and economic fronts. Both competitions depend critically on new technology. The technological importance on the military front was demonstrated convincingly by the Manhattan Project during World

War II and many times since then. On the economic front, Dr. Robert Solow, winner of the 1987 Nobel prize for economics, has demonstrated convincingly that long-term economic growth rests substantially on investment in the development of technology that flows from investment in R&D.

The nation's current budgetary difficulties demand that we look for more synergism in federally supported defense and civilian R&D expenditures. The pressure will be particularly great on defense R&D because it comprises approximately 75% of the total federal R&D budget. The nuclear weapons laboratories with strong efforts in both areas offer great opportunity for highly leveraged federal investments.

Our nation's international economic competitiveness has suffered as Europe and, particularly, Japan have become more innovative than the United States in turning research into useful products or services. Our lead in basic research and in generating new ideas has kept us close. However, even here, our competition is gaining by investing heavily in basic research. For example, Europeans have won the last four Nobel Prizes in physics.

The United States is re-examining the links from science to technology to application. The National Science Foundation (NSF) has embarked on some bold initiatives to improve the ties between universities and industry. The Engineering Research Centers program is well established, and the request for proposals has just been issued for new Science and Technology Centers at universities. The recently announced national computing initiative is another example. These programs will increase university/industry interactions.

The national laboratories can play an important and complementary role. They also contribute significantly to the nation's knowledge pool through basic research by concentrating on multidisciplinary research and research at large facilities. They also design, develop, and operate large, national user facilities such as accelerators, pulsed-neutron sources, reactors, and light sources for the scientific community as a whole. They contribute to the training of students through their graduate and postdoctoral student programs.

The laboratories play an even greater role in technology development. They concentrate on high-risk, high-potential-payoff projects where the public at large benefits or the initial profit motives for private industry are remote. These types of projects are well suited for the national laboratories which can field teams of scientists and engineers to perform goal-oriented development and provide solutions to important national problems. Typically, the projects have been in areas of defense or space technologies where the government is the customer. However, the current concern over economic competitiveness behooves us to enlist all science and technology players in this important endeavor. We should develop national laboratory/industry partnerships and even examine the merits of complementing the NSF initiatives with university/national laboratory/industry partnerships. We will make the case that such initiatives will strengthen the national laboratories and, in fact, enhance the ability of the nuclear weapons laboratories to accomplish their primary mission in the future.

III. NUCLEAR WEAPONS TECHNOLOGY

Nuclear weapons have been and will continue to be the cornerstone of U.S. national security policy for the foreseeable future. The principal goal of this policy has been the deterrence of conflict in general and nuclear conflict in particular. The DOE has provided the nuclear weapons that implement this policy, and its weapons laboratories have provided the technical competence that adds unquestioned credibility to it.

Nuclear deterrence has been successful. Conflict among the major military powers has been avoided for over 40 years, and the related political stability has contributed to unparalleled social and economic advances in the United States and the western world. However, there is great concern about global stability in a world with tens of thousands of nuclear weapons, and clearly the superpowers must start on a road to meaningful and equitable arms reduction.

The application of scientific and engineering capabilities to assure the nation's deterrent through nuclear weapons technology remains the Laboratory's primary mission.

In fact, only Los Alamos and Lawrence Livermore National Laboratories have the statutory authority to design and develop nuclear weapons. In conjunction with Sandia National Laboratories and the Nevada Test Site, these laboratories represent the entire nuclear weapons R&D complex of the nation.

A. Trends and Realities in a Changing Environment

A decrease in tensions between the superpowers will hopefully let us realize a reduction in nuclear arms. The proposed summit meeting on December 7 between President Reagan and General Secretary Gorbachev should bring about a treaty on short-range and intermediate-range nuclear forces in Europe. Considerable discussions have also been held on strategic arms reductions. Hence, it is likely that we will see a world with fewer nuclear weapons in the future.

However, the current imbalance in conventional military capabilities is so heavily in the Soviet Union's favor that the United States will still need to rely on nuclear deterrence for the foreseeable future. In addition, it is clear that the nuclear genie cannot be put back into the bottle, so our national security strategy will never be able to ignore nuclear weapons. Additionally, in the case of drastic reductions in the superpower nuclear arsenal, the nuclear capabilities of other countries loom even more important than they do today.

We believe that the DOE nuclear weapons laboratories face even greater responsibilities and challenges in a world with fewer nuclear weapons. We will still have the statutory responsibility to provide nuclear weapons technology to assure a nuclear deterrent. With fewer weapons, those remaining become more important. Their military characteristics and reliability will be especially critical to preserving strategic stability.

Although reductions in strategic nuclear arms are desirable, they must be done in a rational and equitable manner. Because of the very different force structures (balance among intercontinental ballistic missiles, aircraft-delivered systems, and submarine-launched ballistic missiles) of the United States and the Soviet Union, the superpowers will not be able to reduce nuclear arms through a simple formula. Careful consideration will have to be given to maintaining strategic stability.

The changing scenario will undoubtedly require a "modernization" of our current nuclear force structure, especially because some nuclear systems have been in stockpile for over 30 years. Modernization, however, will continue to mean different and fewer systems, not more weapons.

Reductions in strategic nuclear arms will place even more stringent requirements on the nuclear weapons laboratories, especially if these developments are followed with greater restrictions on underground nuclear testing. Our understanding of nuclear weapons phenomena is still quite empirical because of the enormous complexity of nuclear weapons. The nature of these phenomena cannot be easily simulated and, hence, underground nuclear testing is absolutely vital to our understanding of nuclear weapons.

We must continue developing new replacement systems for a number of other reasons. We must continue to emphasize the safety and security of systems to prevent unintended use or accidents, all the while maintaining the systems' viability. Incidents such as the Grand Forks Air Force Base B-52 fire and the Little Rock, Arkansas, Titan missile explosion, both in September 1980, must not pose a threat to public safety or to service personnel. Even greater robustness will be required of future weapons designs. We may also have to redesign systems if they become vulnerable to various countermeasures.

Finally, reductions in strategic nuclear arms will require an improved ability to verify any arms control agreements. Such an ability is an issue to be resolved early in the arms control process and not considered as an afterthought following negotiations.

B. Ramifications

These changes will have many ramifications for the Laboratory. Even in an environment of reduced nuclear stockpiles and increased restraints on underground nuclear testing, important nuclear weapons work remains to be done.

We will have to improve our predictive capabilities. At present we rely very heavily upon underground testing to support and verify all aspects of the nuclear weapons design and development process. Improved predictive capability means that we must come to a better understanding of the basic properties of materials so that we can predict how they will perform. It also means that we will depend more upon improved weapons physics in our computer codes that simulate nuclear weapons phenomena. These computer codes have taken many years to evolve and are basically the operating repositories of our physics knowledge. Particularly in a time of testing restrictions we need to improve our predictive capabilities so that our computer codes can more accurately predict weapons phenomena in unfamiliar regimes of physics.

We must improve our testing capabilities of nonnuclear components of nuclear weapons. We already test many components of nuclear weapons with experiments not requiring nuclear explosions. This testing must be backed up by extensive experimentation using nonnuclear explosives and x-ray radiography to determine the effects of changing materials and geometries. We can test electrical systems, and we can do experiments to obtain data on how materials react to different environments. We need to find better ways to study the behavior and effects of nuclear weapons using more nonnuclear above-ground tests and fewer full-scale underground tests.

We must continue to maintain and strengthen a number of specialized programs and facilities centering upon the Inertial Confinement Fusion (ICF or laser fusion) program. The ICF program contributes to both our nuclear weapons program and our civilian fusion energy program. The rapid response of the national laboratories to SDI laser technology requirements was made possible by the laser technology base established in the ICF and other programs. As another example, the national laboratories' laser isotope separation programs on nuclear materials grew out of the ICF program. Capabilities developed in the ICF program have already contributed substantially to the support of the nuclear weapons program in the areas of physics modeling, diagnostics, and materials development. Presently at Los Alamos, Aurora, a 10-kilojoule krypton fluoride fusion laser, is under construction and will become operational in FY88.

Recent progress in the national ICF program has increased our confidence in the feasibility of controlled fusion reactions in the laboratory on a microscale. Accordingly a major thrust in the ICF program is the definition and development of plans for a Laboratory Micro-Fusion Facility. Realizing the potential would widen the range of weapons physics studies and simulation of weapons effects that could be studied in the laboratory.

Other unique facilities will also become increasingly important. PHERMEX is a high-intensity x-ray machine that can take a snapshot picture of nuclear material as it is being imploded by nonnuclear high explosive. LANSCE, the Los Alamos Neutron Scattering Center, uses the output of a high-energy proton accelerator and a proton storage ring to create the highest intensity source of spallation neutrons (neutrons produced by high-energy proton collisions) in the country. The Los Alamos Critical Experiments Facility (LACEF) is a DOE resource that serves the broad needs of the nuclear weapons community. This spans the range from measurements of the performance and safety of traditional nuclear weapons and nuclear-directed energy weapons to verification of calculations essential to the criticality safety of proposed nuclear material storage schemes. Such information is important in the design of nuclear weapons production and nuclear materials processing facilities, where the tradeoff between cost and safety must always be conservative (costly) if reliable data are not available.

Increased arms control or testing constraints mean that we will have to improve our verification capability. Beginning almost 25 years ago with the development and delivery of satellite instrumentation for verification of the Limited Test Ban Treaty, Los Alamos became a national resource for verification technology. Negotiations are under way for sharing the Los Alamos CORRTEX technology with the Soviets to measure the underground yield of future nuclear tests. CORRTEX employs a cable in a hole drilled near an underground nuclear weapons test and would assure mutual compliance in treaties limiting the yield of nuclear tests. Other test verification technologies can be further developed such as the infrasound detection system, which measures very low frequency sound waves that propagate through the atmosphere after an underground nuclear explosion. With infrasound we try to "hear" an underground test and distinguish it from an earthquake. Of course, all these verification methods complement seismic methods.

We may have to help develop new verification satellite systems that can survive in a more hostile environment and provide more comprehensive information. New on-site monitoring capabilities should also be developed, and we need a proven approach for ultrasensitive detection and identification of nuclear materials.

To monitor compliance with testing and stockpile reduction treaties, we must continue to improve our nuclear materials verification technology. The task of the United States in detecting any covert production presently appears almost impossible. On-site inspection will be required, and additional monitoring technologies must be developed. Tritium production will be extremely difficult to monitor. Monitoring plutonium production would be made even more difficult should the Soviets recycle material from older weapons or use stockpiled plutonium reserves.

Fortunately, we have made great progress in monitoring nuclear materials. The International Atomic Energy Agency (IAEA) already monitors nuclear power plants in nonnuclear weapons countries using methods and instruments developed at Los Alamos to check for the diversion of strategic nuclear materials. We continue to provide training for IAEA inspectors. We have the expertise and experience to make a significant contribution in arms control and verification technology.

Finally, any conceivable new arms control treaty will increase the difficulty and importance for the U.S. intelligence community to understand Soviet nuclear weapons capabilities. We must be assured of mutual compliance and avoid technological surprise. Fewer weapons in the Soviet stockpile will require improved intelligence information on those remaining. The "national technical means" of verification, such as satellites, provides an acceptable risk when the U.S. stockpile is large but not if it is small. Los Alamos has unique technical expertise and experience in many areas of intelligence that could enhance the national intelligence mission. Areas include material assessment, image enhancement and restoration, SDI-related intelligence, and hardware development.

C. Nuclear Competence

Nuclear competence is imperative if the United States is going to continue to ensure the safety, security, survivability, and military effectiveness of its nuclear weapons. This competence has carefully evolved at the DOE nuclear weapons laboratories over the past 40 years and will be required as long as there are any nuclear weapons at all. It is reinforced in every stage of the laboratories' involvement in nuclear weapons: research, development, testing, production oversight, stockpile surveillance, and retirement.

Crucial to any successful policy of mutual nuclear deterrence is the certain belief of national leaders that their own and their adversaries' nuclear forces are survivable, are deliverable, and will function as intended under any circumstances. This certain belief does not rest on any technical knowledge on the part of the national leaders. It rests on assurances given to those leaders by scientists and by the credibility that these scientists have with their leaders. This confidence comes from the technical expertise we call nuclear competence.

The nuclear competence and, therefore, the credibility of the U.S. nuclear deterrent policy rests indispensably upon the credibility of the three DOE nuclear weapons laboratories. These laboratories are a very fragile technology base. We have supported arms reductions for the past two decades, and we continue to support them. But we recognize that we must retain nuclear competence in the laboratories and in the DOE/Defense Programs complex.

Testing is one of the most important elements of establishing competence in any high-technology venture. It is indispensable in the automotive industry where hydraulic shakers take an automobile frame through millions of cycles simulating road tests; in the aeronautics industry where wind tunnel tests help shape new designs; in the aerospace industry where almost every component is flight tested before acceptance; and in almost every other industry imaginable. In fact, government, tax payers, and consumers alike would consider it a breach of professional ethics not to test a product before placing it on the market. Congress has recently instructed the DoD to improve all its testing procedures, an instruction manifest in the creation of the Office of Operational Test and Evaluation.

The need for testing nuclear weapons is fundamentally no different from the need for testing any other technological system, and our goal should be adequate nuclear testing as long as we rely on our nuclear deterrent. Nonnuclear components receive immense scrutiny and are statistically tested. The nuclear components, however, present a problem because of their enormous destructive power, the complexity of the tests, the limitations already placed on nuclear tests, and the substantial costs and effort. These factors currently restrict us to a few tests on configurations that often must be modified from the weaponized production devices actually deployed in our forces.

In addition, the physical phenomena that occur in nuclear fission and thermonuclear weapons are so complex and insufficiently understood that even today we cannot design weapons from first principles of physics or by computers alone. Furthermore, the conditions that exist during a nuclear implosion cannot be simulated adequately in laboratory experiments. Hence, the design process is an iterative one involving theory, computer modeling and calculations, nonnuclear laboratory tests, and underground nuclear tests. Nuclear tests are essential in calibrating the theoretical models. In a similar fashion, nuclear tests provide the final word on warhead engineering and packaging of components. The subtleties of many engineering changes on warhead design are often more difficult to model and predict than physics design changes. Nuclear tests also help assess the effects of stockpile conditions such as aging and stockpile-to-target environments, including potential effects of hostile nuclear environments.

Hence, nuclear testing is imperative to maintain the nuclear competence and judgment of our nuclear designers and engineers. Every nuclear test is important in building and validating their nuclear competence, regardless of whether the test was aimed at elucidating the physical principles of nuclear implosions or checking the performance of stockpiled weapons. Both the successes and failures in the test program contribute to a better understanding of nuclear weapons. Current restrictions on testing (especially fiscal constraints that control the number of tests) demand that tests be designed to maximize the information we obtain from every test.

Nuclear competence is essential in modernizing the design of nuclear warheads. Modernization is necessary because the Soviet Union continues to protect its strategic forces by making them invulnerable to conventional weapons. The Soviet strategic target base is continually changing. Strong evidence suggests that major strategic facilities are being buried deeply underground, and we know that strategic mobility is being emphasized. New systems will be needed to replace retired systems in order to maintain the strategic balance in this environment. As mentioned above, modernization will be required to proceed with an orderly and equitable build-down of nuclear weapons.

Modernization includes not only new designs to meet a new threat, but also modernization for reasons of improved security and safety plus enhanced command and control features for the warheads. For example, to date less than a third of our systems has been modernized to use insensitive high explosives, an alteration that dramatically reduces the risk of detonation of the high explosive in the weapon and thus of plutonium dispersal in the event of an accident or deliberate attack on the weapon itself. This improvement is impossible without nuclear tests. Stockpile modernization conducted with the essential component of nuclear testing has allowed the United States to actually decrease the size of its nuclear arsenal. Over the past 20 years, the number of nuclear weapons has been reduced by 25% and the total yield by a factor of almost 4. Hence, modernization emphasizes building different weapons to maintain a credible deterrent, not building more weapons of greater destructive power.

Nuclear competence is vital for all aspects of maintaining nuclear weapons in addition to the design issues discussed above. The judgment of competent designers and engineers is required for (1) developing and producing nuclear weapons materials and answering literally hundreds of questions per year about specific fabrication procedures or advisable exceptions to procedures, (2) assessing the effects of long-term variations such as aging in stockpile, (3) maintaining safety and security in both stockpile and transportation environments, (4) assessing risks of potential accidents, (5) assessing the credibility and potential hazards of deactivating a terrorist nuclear device, (6) conducting intelligence analysis of the nuclear capabilities of potential adversaries, and (7) continuing the technical analysis of arms control agreements. This long list demonstrates that nuclear competence is critical as long as the United States depends on nuclear weapons for deterrence. I am convinced that this competence will fade if funding for nuclear weapons technology is reduced.

D. The Production Complex

Our concern for excellence in our primary mission of nuclear technology extends beyond our own Laboratory. Much of the nuclear weapons production complex is over 30 years old and needs to be modernized for better efficiency and compliance with today's more stringent safety and environmental requirements. In the fall of 1986, DOE/Defense Programs initiated an internal study of the status of the nuclear weapons production complex and requirements for modernization. In addition, the House Armed Services Committee FY88 authorization report requires the President to submit a plan for modernization of the nuclear weapons complex, including the research, development, and testing facilities, by February 15, 1989.

The nuclear weapons laboratories should continue to provide support in R&D of environmentally acceptable, more efficient, less labor-intensive and safer processes for the production complex. We have already contributed significantly in several areas, including (1) advanced plutonium technology, (2) tape process manufacture of detonators and detonator cables, (3) plastic-bonded explosives, and (4) insensitive high explosives.

The fragile state of the nuclear materials production facilities is of particular concern today. Los Alamos joins with these facilities in developing process technologies that improve productivity, mitigate environmental impacts, and enhance operating safety. These efforts are coordinated and implemented through the Materials Management Executive Committee (Defense Programs complex-wide membership) and the Plutonium Technology Committee (DOE, Rocky Flats Plant, and Los Alamos). For example, we have recently developed and transferred to the Rocky Flats Plant ion-exchange technology for use in the purification of plutonium scrap. Implementation of this technology at Rocky Flats has significantly enhanced process efficiency and reduced waste generation.

One option for enhancing the supply of weapons-grade plutonium is provided by the Special Isotope Separation (SIS) program that has the objective of using isotopically selective laser emissions to remove unwanted plutonium isotopes and provide material that meets the isotopic purity criteria for weapons-grade plutonium. The Los Alamos Molecular Laser Isotope Separation (MLIS) process for plutonium isotope separation has produced the only currently operational plutonium isotope enrichment system, PHOENIX Phase I. This system is using plant prototypical equipment to demonstrate the high single-stage enrichment factors needed as a basis for plant design. We are completing technological development of the MLIS process and are preparing to fabricate the Phase II system that will, for the first time, demonstrate the use of a laser technique for producing useful amounts of enriched plutonium. The MLIS process is well suited for its primary mission of providing small quantities of isotopically tailored plutonium for research. The process provides DOE/Defense Programs with a viable back-up for the primary SIS mission of production of weapons grade plutonium.

Los Alamos capabilities in plutonium processing R&D for technology transfer to the nuclear materials facilities will be increasingly more important as DOE moves to replace aging facilities.

E. Concerns

We cannot allow the promise of a world with fewer nuclear weapons to lull us into a mood of complacency about maintaining our nuclear competence. Significant arms reduction will make the world a safer place only if we do it correctly to preserve stability through deterrence.

The specific nature of deterrence is difficult to define and changes continuously. We believe that it is precisely the dynamic nature of deterrence (that is, the ability of a nation to respond to changes, be they evolutionary or surprise) that makes the weapons laboratories an indispensable part of the deterrent. Through their scientific and technological capabilities, they have the ability to anticipate or respond to such changes.

Hence, we hope that the current budgetary difficulties and those we are certain to face in the next few years do not erode the capabilities and nuclear competence that we have so carefully developed over the past 40 years. Once lost, such competence is difficult to regain.

IV. AN EXPANDED DEFENSE ROLE

Modernization and improvement of U.S. conventional weapons will necessarily have to accompany reductions in our nuclear arsenal. Advanced technologies will be crucial to all military systems because it will be very difficult to match the numerical Soviet superiority.

We recognize that there are already many Department of Defense R&D facilities and that the DoD employs most of the nation's science and technology sectors. The Defense Advanced Research Projects Agency (DARPA) and the individual military services contract R&D with (1) universities, (2) "not-for-profit" laboratories (such as Battelle), (3) the national laboratories, and (4) industry. The individual services operate many federal laboratories, most of which focus on specific development and technology issues of current interest to the services.

The DOE nuclear weapons laboratories are beginning to add a new dimension to the R&D capabilities of the defense complex. We have maintained first-rate scientific institutions doing forefront research while having a defense orientation, which gives us the capability to quickly translate research ideas into defense concepts. And, more importantly, we have both the creative individual scientists and the project-oriented technology teams to develop both the ideas and the technologies. Our response to the President's Strategic Defense Initiative, which we will discuss below, is an excellent example of our capabilities and contributions.

The nuclear weapons laboratories can complement current DoD-sponsored R&D by using their broad science and technology base to solve important problems for the services and by developing the science and technology base that will be required for the next generation of weapons and defense. We believe that these efforts will put the United States into a much better competitive position in the next century when we will rely more heavily on conventional military power. However, to optimize the contributions of the nuclear weapons laboratories we will need to develop more effective institutional relationships between the DOE, the DoD, and the laboratories. Also, the laboratories will have to develop new partnerships with industrial contractors to expedite the transition from research to technology to military hardware.

A. Current Programs

The Laboratory has already broadened its defense role to include over $200 million (25% of our budget) in nonnuclear defense and intelligence work, primarily for the DoD. This work is concentrated on strategic defense research, conventional munitions, and advanced concepts.

The Senate Armed Services Committee has encouraged the DOE to have its nuclear weapons laboratories contribute to conventional weapons research. The DOE and the DoD have entered into shared block-funding agreements through memoranda of understanding with the Army and with the Office of the Secretary of Defense. Under these agreements, Los Alamos has already taken on substantial nonnuclear weapons work, emphasizing advanced conventional munitions, chemical and biological defense, and other advanced concepts.

Los Alamos serves as the Advanced Technology Assessment Center in the DARPA/Army/Marine Corps Armor/Anti-Armor Program. In this role, we conduct competitive evaluations of new armor and armor-penetrating hardware developed by teams of U.S. industrial contractors against hardware and systems designed to represent current and future Soviet technology and analyze the results. We also carry out fundamental research that underlies the development of improved armor and anti-armor technology in this program.

Our response to the President's speech in March 1983 that established the Strategic Defense Initiative shows how the Laboratory's talents can quickly concentrate on addressing a program of national importance. Related programs already under way on nonnuclear-driven directed- energy concepts employing advanced technologies in accelerators, lasers, optics, and computers paved the way for accelerated development of advanced concepts of importance to the SDI. Our work on neutral particle beams (NPBs), free electron lasers (FELs), and battle management (BM) for the SDI has become the largest component of our work for the DoD.

B. The Importance of Nonnuclear Defense Work

In evaluating potential nonnuclear defense areas to pursue for the DoD and the intelligence community, we apply several rigorous criteria. The work must contribute to the solution of an important national problem. It should have significant scientific and technical value. It must also complement and strengthen our primary mission of contributing to deterrence through nuclear technology. Indeed, without our current support for advanced conventional munitions, we could not sustain the level of capability in fields such as explosives, diagnostics, materials science, and computer simulation that we feel is necessary to accomplish our primary mission. An expanded role in nonnuclear defense will preserve and enhance our nuclear competence.

The DOE laboratories bring to the nation's nonnuclear defense and intelligence programs an enhancement of the innovation cycle, from basic research to customer interaction. At Los Alamos, scientists and engineers remain at the cutting edge of their expertise by maintaining the necessary research ties to universities. But because Los Alamos is also an applied science laboratory with a defense orientation, we are able to quickly recognize the connections between research and application. We also have experience in collaborating with industry to address problems in taking the step from exploration to development. Currently, few, if any, other organizations can fill these gaps between true research, exploratory development, and production as well as the DOE nuclear weapons laboratories.

C. Contributions of Nonnuclear Defense Work

Many opportunities exist for further applications of Laboratory capabilities to solutions of important problems for the DoD and the intelligence community. In addition to broad opportunities in areas of interest to each of the services, there are joint efforts involving the Office of the Secretary of Defense, including DARPA. There are also focused efforts such as the Balanced Technology Initiative (BTI) and the Conventional Defense Initiative (CDI). The CDI exploits currently available systems and advanced technologies, whereas the BTI focuses on development of technologies that will provide the weapons systems of tomorrow.

To carry out our nuclear weapons technology mission, we have invested heavily in unique capabilities in several specific technical disciplines. Many militarily significant technologies described below draw heavily on these capabilities that are not found elsewhere. Unique disciplines and facilities include explosives, sensors, diagnostics, field testing, advanced materials, accelerators, high-power lasers, computational science, information processing, and pulsed power.

New materials development and explosives technology contribute directly to new armors and penetrators. A whole spectrum of potential defense applications is offered by the recently discovered family of materials that are superconductors at relatively high temperatures. A few examples include radio-frequency accelerator cavities for the NPB and the FEL, infrared sensors, magnetic shields, radio-frequency power conditioning, and materials optimization.

Innovations in information processing and ultraspeed graphics could have a tremendous impact on intelligence gathering and "smart" weapons. In the former case, advanced computational architectures utilizing many parallel processors could handle complex data problems that are intractable today. This area will receive continued emphasis within the Laboratory because of our strong history in advanced supercomputer calculations for the nuclear weapons program. In the case of smart weapons, we have the opportunity to couple our capabilities in ultrafast sensors with our research into advanced computing. By using advanced computational techniques, we may be able to develop the previously unattainable pattern-recognition algorithms required for weapons to learn the environment and identify the targets. Although these projects require long-term R&D, they match well the skills and talents at the nuclear weapons laboratories.

The area of advanced optical technology is ripe for exploitation in the conventional weapons area. Navy applications for optical technology include antisubmarine warfare, submarine laser communication, and countermines. There is a rapidly growing need to protect our optical sensors against the Soviet laser threat. Currently, our forces have only a very limited protection against fixed-wavelength lasers. The wavelength-agile threat will appear on the battlefield in the near future, with the United States having no promising concepts for useful protection. We have the unique combination of capabilities in materials science, chemistry, and nonlinear optical physics to effectively address this pressing issue. The directed-energy technology that is being developed for SDI will have a significant impact on many non-SDI defense applications. For example, compact FELs could be space-based as a component for air defense against cruise missiles or bombers. If a hostile object is visible, a kill with this type of laser may someday be possible. Compact FELs could also improve fleet defense because such lasers could be based on ships to defend against standoff weapons carried by long-range attack bombers.

We can develop generic enhanced-effects warheads, which naturally follow our earlier development of long-standoff penetrators and explosively formed projectiles. This area includes microwave munitions, optical munitions, hypervelocity-fragment warheads, and neutron-beam warheads. A microwave munition is a source of high-power microwaves driven by a high-explosive-driven pulse-power generator that could provide significant leverage in either land or sea battle. It is possible that the communications/radar link can be broken down with such weapons. The energy of an optical munition can be used in an antisensor role. In this concept, explosive energy is converted to intense light emission covering either a large area (noncoherent) or a directed, collimated laser beam for large ranges. A hypervelocity-fragment warhead would use a special high-explosive design to generate a directed cone of fragments having high lethality and relaxed aiming requirements. This warhead has potential applications against anti-cruise missiles for ship defense, and as an antitactical ballistic missile (ATBM). The high-explosive-driven neutron-beam warhead may be one of the few plausible approaches to ship defense against nuclear-tipped cruise missiles. If this concept were to become reality, it may be capable of defending our ships both within and without the nuclear keep-out range.

An area where we can make substantial contributions to solution of nonnuclear defense problems is in the development and application of advanced sensors, diagnostics, and detection systems. This contribution is exemplified in development of ultrasensitive devices for the remote detection of chemical and biological warfare agents. This technology could be exploited on the battlefield as well as in the verification of arms control agreements involving chemical and biological warfare. High-performance laser sources and optical filters represent new candidate solutions to this problem. The Laboratory has the critical mass of life scientists, chemists, and optical experts to address this need. Advanced sensors are also potential components of battle management systems that could be developed as an extension of our information processing and numerical simulation capability.

We are in a particularly strong position to develop technological solutions to problems in the field of low-intensity conflict/special operations/counterterrorism, which has become an extremely important security issue worldwide. Our relevant capabilities here include computation, materials science, diagnostics, integration, critical review and assessment, and security. The problems for which we foresee meaningful technological solutions include explosives detection, chemical and biological threat detection, technological response to threat(s), small team decontamination, and microwave disruption of electronics.

The technical expertise and experience at Los Alamos can be brought to bear upon innumerable national security programs faced by the intelligence community. Areas where the Laboratory can expand its role in the intelligence community include material assessment, image enhancement and restoration, computing, foreign weapons capability, SDI-related intelligence, and special hardware development.

D. Concerns

The opportunities for potential nonnuclear defense contributions by the nuclear weapons laboratories are numerous, but to exploit the full potential of these laboratories, we need long-term R&D relationships with the DoD and the intelligence community like the ones we have with DOE/Defense Programs.

Many of the projects we now do under DoD and intelligence community sponsorship are paperwork and management intensive because of the contractor-like environment in which we perform. Also, many of the projects are of the job-shop nature and do not fully exploit the long-range R&D capabilities of the Laboratory. Our ability to play an intermediary role with universities and industry requires an acceptance by the DoD that there are long-term problems worth investing R&D dollars in and that reasonably stable funding can be provided for the nuclear weapons laboratories to address those problems. Without such an approach the United States could find itself "surprised" by Soviet advances like those recently discovered in the armor/anti-armor arena. In contrast, we have had no surprises in the nuclear weapons arena because the DOE weapons laboratories were supported to stay at the forefront of nuclear weapons science to avoid such surprises and to provide options to the United States with new technological developments.

However, nonnuclear defense projects will require new alliances between the weapons laboratories and industry to translate the long-term ideas into applications. Our collaboration with and transfer of technology to the Boeing Aerospace Company (FEL technology) and the McDonnell Douglas Astronautics Company (NPB technology), as well as our interactions with over two dozen industrial contractors through the Advanced Technology Assessment Center in the DARPA/Army/Marine Corps Armor/Anti-Armor Program, represent a beginning of these relationships. An additional impediment to the development of a broader defense role is the burdensome administrative requirements for work that the DOE laboratories perform for other governmental agencies. The management effort and the time required to process proposals and funding documents necessary to initiate or continue projects for the DoD and the intelligence community are excessive. In addition, the very restrictive financial accounting requirements on a project-by-project basis add to the administrative requirements.

We are concerned about the long-term stability of our role in SDI. The initial objective of this program has been to carry out the R&D to evaluate potential concepts and technologies to decide whether they merit being taken to full-scale engineering development and potential deployment as elements of strategic defense systems. Because the role of the nuclear weapons laboratories is concentrated in the R&D phase of SDI, our involvement at the current, high level is intended to be sustained for a finite time period. The challenge that we face in the long term will be to apply the concepts, technologies, and capabilities developed in the SDI program to additional problems of the kind mentioned above and to identify alternate, related programs of national importance to which we can uniquely contribute.

The support of our nonnuclear SDI work is also a concern. With the completion of the Defense Acquisition Board "Milestone One" review of the Phase I Strategic Defense System, this system has entered the demonstration/validation phase. Because actual SDI budgets have not kept pace with those projected in the initial program plan, the combination of overall budget shortfalls and the commitment to carry out costly demonstration/validation experiments on the Phase I kinetic energy concepts threatens the funding for advanced, nonnuclear-driven directed-energy concepts such as the NPB and the FEL. With the current SDI budget trends, SDIO must be careful not to let research and development of new concepts fall behind demonstration of more mature ones. Timely evaluation and development of advanced concepts such as directed energy weapons would be essential in Phase II and beyond to augment the capabilities of an initial deployment of a strategic defense system.

E. Directions

The recommended approach to the current situation facing conventional and nuclear weapons development is to recognize the strengths of the DOE nuclear weapons laboratories and to further utilize their unique talents to complement the DoD laboratories and industry. The DOE laboratories have extensive experience in pulling together multidisciplinary teams to address complex national security problems. They also have close ties to the university community and are involved with industry through technology transfer. All these strengths could be used to support nonnuclear defense. This possible approach has been recognized by several studies, including the President's Blue Ribbon Task Group on Nuclear Weapons Program Management (1985) headed by Judge William P. Clark, Jr. The DoD has already given significant support to Los Alamos in the areas of SDI and nonnuclear weapons. Such support should be expanded, and the mode of interaction should be improved. Not only could we make a more substantial contribution to DoD programs and the intelligence community, but also such increased support would enhance nuclear competence and synergistically fit with our other programs.

In summary, to effectively achieve a broader defense role, we require several ingredients: more stable long-range R&D funding and a better-defined role for the DOE in this area to remove the current roadblocks to these activities. If these concerns can be addressed, the nuclear weapons laboratories can offer the defense community first-rate scientific expertise with a defense orientation and can establish their science and technology roles in certain DoD and intelligence community areas complimentarily to their nuclear weapons roles.

V. NONDEFENSE ACTIVITIES: RESEARCH AND ADVANCED TECHNOLOGIES

A. Nondefense R&D

The discussion to this point has illustrated the important contribution a first-rate multidisciplinary scientific and engineering institution can make to the defense needs of the country. The need for several defense research institutions of unquestioned quality is of crucial importance to the United States because we depend so critically on advanced technologies for our defense rather than on the sheer size of our forces. This section raises an important question. In addition to the strong mission requirements and technical challenge of our defense responsibilities, what other ingredients are required to ensure a defense research institution of the highest quality?

Our experience has demonstrated many times over that a first-rate basic research program and a challenging set of nondefense programmatic efforts addressing important national problems are key ingredients to excellence. In our opinion and experience, the size of the nondefense programs should be at least 25% of the activities. At Los Alamos, this work has slipped to 22% of the budget. Nondefense basic and applied research are fundamental ingredients to attracting first-rate professional staff because the research literature, the unclassified scientific popular literature, and the publicly visible accomplishments are keys to institutional reputation. Ties to universities, where most of our country's basic research is done, ensure an inflow of talented new graduates to feed the professional work force. Defense programs characteristically have much weaker university ties.

Also, nondefense R&D activities making noteworthy contributions more generally allow the Laboratory and its work to have greater public visibility and support, thereby further strengthening the defense programs. Finally, to perform the defense role well, participation in all relevant aspects of science and engineering allows early consideration of defense applications of new discoveries and protect against technological surprise from our adversaries.

Even more important than the institutional benefits of nondefense research and development programs is the fact that Los Alamos can produce *solutions* to important national problems. The multidisciplinary capabilities of the Laboratory allow novel solutions to national problems that most other institutions cannot match. The basic research capabilities of universities are strong but often not goal oriented; applied R&D is not and should not be their forte. Industry often does not have the time or the profit motive to attack certain important long-range problems. Examples include advanced energy technologies and technical solutions to some problems in the health and environmental arenas.

B. Basic Research

The DOE multiprogram laboratories have made impressive contributions to the nation's knowledge pool, and we at Los Alamos are proud of our contribution. Compared with universities, the strengths of the laboratories have been in multidisciplinary basic research and research requiring the use of large facilities. The majority of basic research at Los Alamos is funded by the Office of Energy Research (OER) at DOE. The Office of Basic Energy Sciences (BES) of OER funds exciting research efforts in, for example, materials sciences, computational sciences, geosciences, and advanced energy projects. More specifically, our efforts to understand the dynamic atomic and molecular processes associated with muons, negatively charged particles 200 times the mass of electrons, interacting with deuterium and tritium atoms have made important contributions. The eventual goal of this research is to determine the practicality of catalyzing deuterium and tritium fusion with muons. The Division of Materials Sciences of BES funds the Los Alamos Neutron Scattering Center (LANSCE). When fully operational, LANSCE will be the nation's premier facility for pulsed neutron scattering for materials science and condensed-matter physics research.

The flagship of basic research at Los Alamos is the Clinton P. Anderson Meson Physics Facility, (LAMPF) the world's most intense proton accelerator with energies in the 800-MeV range. This facility is funded by the Office of High Energy and Nuclear Physics of OER. LAMPF provides secondary beams of pions, muons, and neutrinos and provides the proton source that yields neutrons at LANSCE. This user facility brings to Los Alamos 300 to 400 experimenters per year, adding to institutional prestige and introducing graduate students and postdoctoral fellows to the Laboratory. Key discoveries have emerged from LAMPF, including the first detailed measurement of the electron-electron neutrino scattering cross section, which helped to verify the electroweak theory of nuclear interactions.

In addition to its contribution to the nation's knowledge base, basic research is the life blood to ensure the future of the Laboratory. New Ph.D.s hired at Los Alamos conducted basic research at universities before arriving and are often attracted because of the Laboratory's basic research efforts. These staff members over their years at the Laboratory often gravitate to the defense programs and provide an important source of talent augmenting direct recruitment of professionals into defense projects.

A significant basic research program also strengthens the institution in ways that are more difficult to measure. An atmosphere of creativity and innovation flourishes when investigators let their intellectual curiosity lead them in interesting new directions. Such research is conducted without strict guidelines or detailed milestones. The intellectual vitality is contagious and imbues the entire Laboratory with an aura of inquisitiveness. In such an environment, applied research and exploratory development are less endangered by a drift toward overly structured thinking and excessive conservatism in approaching the solution to problems. There is a much better balance between responding to program goals and the need for creative ideas to provide the best research product. Further, an environment of balanced basic and applied work produces a creative staff that is broad and flexible, accustomed to pursuing new directions and, therefore, able to contribute to solutions for future problems.

Basic research efforts must be sufficiently large at the Laboratory to make a difference. We invest in basic research through our institutional supporting research and development program, which draws upon all of our programs for its funding. The continued strengthening of the OER budgets is also very important to Los Alamos to for maintaining excellence in basic research. It is important that OER program staff continue to view all DOE laboratories, including the weapons laboratories, as their clients, equally worthy of support based upon the merits of the proposals.

By far the most significant new idea we have proposed is an Advanced Hadron Facility to be built in the mid 1990s. This $400-$500 million facility, using protons injected from LAMPF, will be a national user's facility where forefront nuclear and particle physics will be conducted using 60-GeV protons. The long-range plan for the national nuclear physics program calls for a facility of this type after completion of continuous-electron-beam and heavy-ion accelerators. A facility of the former type is presently being constructed at Newport News, Virginia, and a heavy-ion accelerator is nearing approval to begin construction. The Advanced Hadron Facility will be useful to the nation in complementing the superconducting super collider and vital to Los Alamos in maintaining itself as a first-rate institution performing its defense mission in the most creative way.

C. Energy Technologies

Let me now focus on another area of national importance, energy research and technology. An adequate energy supply and a reliable energy distribution system are essential for our nation's security and economic health. The 1973 oil embargo quickly demonstrated how an interruption of oil imports can impact the economy of the United States and the world. Studies of the vulnerability of energy supplies for various military bases show the need for continued attention in planning for and providing a dependable and secure energy supply for our military forces around the world. The lessening of the 1970s energy crisis has resulted in diminished national media attention and fewer federal funds for research and development of new energy technologies in the 1980s. In a recent report to Energy Secretary Herrington, the Energy Research and Advisory Board expressed the concern that, although *"The primary energy needs of the United States will continue to be met with oil, gas, coal, and nuclear resources for at least the next few decades,"* the nation's energy supply infrastructure is undergoing rapid erosion and the country is *"meeting its energy needs with an ever increasing dependence on imported oil."* This dependence on imported oil could threaten our energy security, international competitiveness, and the standard of living of the United States. Therefore, it is important that Los Alamos and the other national laboratories maintain and, if possible, increase the energy research and technology portion of their activities. This area of research demands a higher priority on the nation's budget even in this time of severely limited resources.

In response to past energy crises, the federal government responded by funding a mixture of programs with payoff potential ranging from the near to the far term. The return on investment of these past programs was less than desired, at least in part, because we did not closely link the R&D with the marketing and commercial focus of industry. Further, we should learn from our past experiences and move forward with positive new initiatives rather than endanger the nation's security by ignoring the possibility of future energy crises. I believe that success is possible by establishing the proper technical partnerships among the private sector, national laboratories, and universities. In the past few years, the DOE national laboratories have increasingly worked with universities and industries to make major contributions in the basic science and engineering necessary to develop, demonstrate, and commercialize new energy technologies. For example, Los Alamos developed and led a major international hot dry rock geothermal program. The concept is being successfully expanded by our international collaborators from Japan and West Germany. We plan to conclude our program by completing a one-year flow test at the Fenton Hill Site in the Jemez Mountains near Los Alamos. We are working with Bechtel Inc. on issues associated with commercialization of the technology. This successful cooperative program has used the science and technology base of Los Alamos and universities and the expertise of industries to demonstrate proof of principle and also produce entrepreneurial spin-offs.

Los Alamos energy research and technology efforts began with contributions to the nuclear reactor development programs in the United States, and current Laboratory reactor programs continue that tradition. These reactor projects strongly complement our nuclear weapons responsibilities by sharing disciplines and facilities. For example, under Nuclear Regulatory Commission sponsorship, the Laboratory has developed the world's most advanced computer codes for analysis of nuclear power plant accidents. Development of these codes began in the early 1970s using expertise and techniques developed in support of the nuclear weapons program. In the last few years, to come almost full circle, the DOE has asked the Laboratory to apply these computer codes and related expertise to help examine the safety of the DOE/Defense Programs reactors at Savannah River and Hanford. The Laboratory is well prepared to expand these efforts as needed for both these existing reactors and for a new production reactor.

The development of nuclear energy has been a natural and integral part of the national laboratories' efforts from the beginning. Current projects at Los Alamos focus on the development of specialized defense-related reactor concepts. From our early involvement with nuclear reactor development, Los Alamos has expanded its interest in energy technologies to contribute to nuclear waste disposal, nuclear safety, cleaner uses of coal, the development of new resources in oil and gas, and the research and development of new energy technologies such as fusion and fuel cells.

Ground was recently broken for the Confinement Physics Research Facility (CPRF) at Los Alamos. The CPRF, with its large power supplies, will provide capabilities for magnetic fusion energy research previously unavailable at Los Alamos. A key element in these power supplies is the new 1430-MVA electrical generator recently obtained from the Tennessee Valley Authority. The first magnetic fusion experiment in CPRF will be ZTH, the next-generation reversed field pinch machine for large-scale fusion plasma studies. When completed in 1992, the ZTH device will have the largest current capability of any reversed field pinch in the world.

In summary, an expanded and newly focussed program for energy security for our country is needed now. The DOE national laboratories in general and Los Alamos in particular have the appropriate science, engineering, and technology base and research facilities to significantly contribute to the development of improved energy technologies that can help ensure the nation's energy security and meet the energy demands of the civilian economy. Further, the most effective use of additional federal resources is to better balance the program between technologies having reasonably near-term potentials such as enhanced oil-recovery research and clean-coal technology with those having midterm payoff possibilities such as walk-away-safe modular nuclear reactors and with those having long-term potentials such as fusion energy. Along with the expertise of the DOE laboratories, the program must also include the research capabilities of our universities and the marketing and business strengths of the private sector in a synergistic fashion. The private sector involvement is key to maximizing the commercial impact of developed technologies.

D. Health and Environment

The multidisciplinary strengths of Los Alamos position the Laboratory to contribute in unique ways to issues of health and the environment. In the health sciences there are noteworthy examples of this multidisciplinary approach. The Los Alamos Human Genome Project, funded by the DOE and the National Institutes of Health (NIH), is part of a national effort to understand human genetic material in a much more fundamental way. The program is oriented to develop technologies to allow a systematic mapping and sequencing of the three billion chemical units (or bases) comprising the genetic material of the human being. Because the ordering of these units determines human development, heterogeneity, and susceptibility to disease, a major effort could have profound impact on human health, including showing the way to treatment of genetic diseases. The DOE has just named Los Alamos as one of two new Centers for Human Genome Studies so that it can contribute its strong capabilities in engineering, biological science, and computational science to this important problem.

Another example is the Los Alamos work in establishing and maintaining the AIDS data base and in computer modeling of the epidemiology of AIDS. This work takes advantage of superb computational resources at Los Alamos. These resources have already produced noteworthy results in discovering that the AIDS virus is mutating at a much more rapid rate than was previously thought.

A final example is a major contribution to neuroscience. By combining the capabilities of our bioscientists, physicists, and instrumentation professionals, we have developed one of the world's foremost magnetoencephalography laboratories. In concert with the VA Hospital in Albuquerque, we will soon begin clinical trials with instruments that, in a noninvasive way, can provide high resolution mapping of the tiny magnetic fields produced by the activity of neurons in the brain. Such work can make significant contributions to the understanding, diagnosis, and treatment of neurological disorders.

The environmental arena also provides great opportunities for DOE national laboratories to contribute. There are 18,000 hazardous waste sites identified for Superfund coverage. Contamination of ground water is a major national health concern that must be addressed. Additionally, the DOE and the DoD have demonstrated increasing concern about their own facilities throughout the country and their impact on the environment. Current techniques have usually limited regulators to consideration of the costly approaches of physically moving contaminated soil or physically immobilizing it. It is of utmost importance that a major R&D program begin to consider novel, drastically less-expensive approaches to this problem. Los Alamos can contribute innovative instrumentation for waste-site characterization, advanced incineration/destruction technologies including novel chemical dynamics, and biological-based approaches, as well as modeling of toxic waste transport through geologic media. The DOE/OER has begun planning a major basic research program in this area. Also, the Defense Programs Office of DOE is funding some applied research and technology development. These beginnings must be strongly encouraged.

E. Space

The Laboratory has long been involved in space science and technology. Our involvement and the resulting expertise base have developed through our programmatic activities in verification (VELA to the present), space power and propulsion (Rover through SP-100), weapons effects on the near-space environment and, most recently, SDI. We have developed an excellent capability in space science derived from our role in satellite instrumentation in the verification program.

Cooperative space science projects (~ $2M in FY87) between individual scientists at Los Alamos and the Goddard Space Flight Center have been extensive and technically challenging. Topic areas have included atmospheric, ionospheric, magnetospheric, interplanetary, and solar physics research projects. Similarly, astrophysics programs across the entire wavelength spectrum and for both galactic and extragalactic investigations have been conducted.

The nation's space program is continually advancing into new areas demanding the most advanced materials and aspects of science and technology. In the area of aerospace research, Los Alamos participates both in the National Aerospace Plane (NASP) program and in the nation's space program. The national aerospace plane effort is jointly funded and jointly managed by DARPA, NASA, the U. S. Air Force, the U. S. Navy, and the Strategic Defense Initiative Office. The objective of the program is to use supersonic-combustion ramjet technology to develop by 1993 an aircraft capable of atmospheric flight at speeds greater than 10,000 mph. In support of this objective, Los Alamos is using a broad-based, applied research program that is being supported by funds from the NASP Joint Program Office at Wright-Patterson AFB.

NASA is placing new emphasis on developing technology for advanced space missions, such as a permanent lunar base and a manned mission to Mars. A significant amount of the technology that must be developed to accomplish these goals can draw from programs currently under way at Los Alamos. Furthermore, several future defense programs will involve exoatmospheric operation and will require new technology development for successful execution. Consequently, this Laboratory is investigating the potential of developing technological capability pertinent to future space missions. The initiative involves applied research and technology development in many scientific disciplines that can be grouped into the general areas of (1) materials science and engineering; (2) life sciences; (3) space-based structures; (4) power and propulsion; and (5) planetary exploration and resource utilization.

Application of the Laboratory's expertise and knowledge-base to civilian programs will complement the capabilities which exist in the NASA and military research centers. Collaborative utilization of these capabilities could greatly enhance the progress and success of the civilian programs.

F. Economic Competitiveness

The world leadership of the United States in technological and new product development is being threatened in an unprecedented way. Yet we have the finest basic research effort in the world, largely based in our universities, and large federal expenditures for basic and applied research, much of which is performed in our national laboratories. To shorten the time to commercialization, the country must better focus on the exploratory R&D (defined as applied research and exploratory development lumped together) phase of the innovation cycle. To date, Los Alamos has made some important contributions to technology transfer. For example, the nuclear weapons laboratories, and Los Alamos in particular have played a significant role in the development of our present state-of-the-art in computer technology, especially in supercomputers. For more than four decades we have provided a consistent and demanding market for improved products, we have shared our technologies with industrial firms, and we have worked with industry to set standards and improve performance. Clearly, the computer industry, in which the United States still boasts supremacy in the international market, has benefitted greatly from Los Alamos and the other weapons laboratories.

Also, the Laboratory has been actively assisting entrepreneurship resulting in a significant array of spin-off companies. The technologies commercialized range from a laser-based biological cell sorter, to low-voltage carbon dioxide laser systems, to a technology for electronic identification of livestock.

However, the approach of attempting to take existing technologies "off the shelf" and commercialize them can have limited success at best. We must focus on exploratory R&D and urge the private sector to introduce market considerations early. This process can best be accomplished through new partnerships between industry and the broader R&D community. The National Science Foundation is attempting to achieve this end through its Engineering Research Centers and its Science and Technology Centers that form university/industry partnerships. We must similarly engage the DOE national laboratories in new ways. The executive and legislative branches of government have both taken action to make it easier for national laboratories to contribute their exploratory R&D capabilities to problems of economic competitiveness. Still, much needs to be done. Key actions are required to facilitate access of industry to the laboratories, including the following.

- Explicitly broaden DOE responsibilities to include application of the capabilities of its laboratories to specific areas impacting economic competitiveness. This should include Congressional authorization and appropriation of funds to the Department to be utilized to bridge the laboratory-to-market gap for selected technologies with commercial applications.

- Dramatically streamline the process of granting class waivers to patents to contractors, where the work clearly does not involve national security, and grant local authority to contractors to negotiate work-for-others agreements with private companies subject to a streamlined process of final DOE approval.

- Encourage industry to work with the laboratories and to fund generic technology development and occasional product development to expedite the translation of research to applications.

The newly discovered high-temperature superconducting materials provide an excellent test case for a pilot program to try out the above mentioned ideas. Energy Secretary Herrington has charged Los Alamos National Laboratory with establishing such a pilot effort. We are in the process of developing a concept paper that will propose pilot exploratory R&D centers at DOE laboratories, a step that will form partnerships with industry in this important arena. These centers will conduct research on the enabling technologies needed to help industry commercialize these new materials. Additionally, they will provide a window on the Laboratory as a whole for industry, making the Laboratory more "user friendly." Hopefully, the experience of this pilot effort will dramatically improve performance in technology transfer.

VI. ISSUES, CONCERNS, AND RECOMMENDATIONS

A. Support for Nuclear Weapons Technology

We cannot overemphasize the need for strong and stable support of nuclear weapons technology. We support meaningful nuclear arms reductions, but even in an arms-control-dominated world, we will need to preserve nuclear competence and guard against technological surprise. The risk of failing to do so is too great for the United States and the free world to accept.

There will be a strong temptation to cut the nuclear R&D budget in order to trim the defense budget and send a symbolic message to the world. Yet, such budget cuts will seriously erode the vitality of the three nuclear weapons laboratories which collectively represent the nation's nuclear weapons technology and verification capabilities. Research and technology provide us with the flexibility to respond to the dynamics of national security and world politics. We cannot afford to foreclose any options now. We can rest assured that our adversaries will not curtail their R&D investment.

Recommendation 1: Maintain the strong and stable funding in nuclear weapons technology and verification and do not limit scientific exploration of new ideas and concepts.

B. A Broader Defense Role

The Laboratory's broad science and technology base developed through basic research and the nuclear weapons work has allowed us to make significant contributions to advanced conventional munitions and nonnuclear defense. We were able to respond rapidly to the President's Strategic Defense Initiative by expanding our research in areas such as particle beams, lasers, computational science, and systems analysis. We are leading an effort with industry to develop new armor/anti-armor technology for a joint DARPA/Army/Marine Corps program.

We also have many small projects aimed at solving specific problems for the individual services. Many of these are conducted in a contractor-type mode and are very management and paperwork intensive, a situation that doesn't necessarily take best advantage of our talents. Our current DoD projects lack stable funding levels and strong institutional commitments.

Unlike our nuclear weapons work where we have excellent ties to the customer (the military) and technology transfer to the nuclear weapons production complex, in our nonnuclear work these interactions are much more diffuse and need to be improved.

The nonnuclear defense work is scientifically and technically challenging. Under the proper funding and institutional arrangements, it can better complement our nuclear technology mission and provide a valuable service to the nation. Areas such as advanced conventional munitions and large-scale, real-time information processing will require advanced computers, expertise in materials science, high-explosives technology, large-scale computational analysis, and well-instrumented experimental facilities, which are great strengths at the Laboratory.

Recommendation 2: A broader defense role for the nuclear weapons laboratories should be actively supported. Congress, the agencies (DOE and DoD), and the laboratories should develop policies and relationships that will encourage the laboratories to contribute to long-term science and technology needs of the broader defense community. The memoranda of understanding between the DOE and the DoD (and encouraged by the Senate Armed Services Committee) to provide block funding for advanced conventional munitions work are an important first step. The laboratories must establish new alliances with the defense industry to translate the science and technology projects into useful military hardware and systems.

C. A Vital Nondefense Role

Research and development in nondefense areas are vital to the scientific excellence of a defense-oriented laboratory. We have unique capabilities that can contribute to our nation's well being and economic strength. Our contributions to basic research and the world's knowledge pool continue to be outstanding. We have also made significant contributions to energy technologies, both nuclear and nonnuclear. We are now contributing to health, environmental, and space research and are exploring ways to help this nation's economic competitiveness through exploratory R&D in high-temperature superconductivity.

Currently there does not exist a very good coupling between the laboratories and industry to translate the nondefense technology work at the laboratories into end products and applications. The coupling needs to be improved in energy technologies and newly established in areas such as health-related technologies and technologies that could enhance our economic competitiveness.

Diversification into technology areas other than nuclear weapons and fission and fusion power has also brought about a concentration on short-term rather than long-term R&D. Institutionally, it has become more difficult to gain advocacy for these new programs, especially because some of them do not clearly fall within the mission of the DOE. Consequently, these programs have also been much more management and paperwork intensive.

Recommendation 3: Continue to support a strong basic research program at the Laboratory. Encourage the weapons laboratories to continue to diversify into nondefense technologies such as energy, health, environment, space, and economic competitiveness. Support the DOE in broadening its responsibility to include at least a partial research and technology role in areas other than energy. Work with the DOE to make the laboratories more user friendly to encourage interactions with industry. Develop new partnerships between the laboratories and industry to introduce the market pull early in the laboratories' R&D work, thereby expediting the transfer of technology from the laboratories to useful private sector products.

D. A Friendlier Atmosphere for Federal R&D Institutions

Government-owned, contractor-operated laboratories were established during and after World War II as a way to bring first-rate scientific talent to bear on urgent technology problems. Contractor operation was also chosen specifically to expedite the cumbersome government bureaucracy in getting results in a goal-oriented project. This system, especially under the management of the University of California, has served the nation well for over 40 years.

We find, however, a significant erosion of these enlightened policies with each passing year. Many of the congressional, administrative, and regulatory requirements are translated into strict regulations by the executive agencies. These regulations have limited the flexibility, discretion, and long-term, high-risk orientation of our research laboratories. Numerous prestigious review panels have cited the need to keep flexibility and discretion and minimize micromanagement and overregulation in order to maintain the excellence of the DOE national laboratories. In addition, the regulatory requirements have eaten substantially into our operating budgets and our efficiency. If unabated, the administrative and regulatory requirements will drive the laboratories to a management policy of avoiding all risk, which is a terminal affliction for an R&D organization.

Recommendation 4: Congress should re-examine the regulatory and administrative requirements imposed on the federal R&D sector, especially the research institutions. The executive agencies should revise many of their regulations that impose inordinate administrative requirements, limit flexibility and discretion, and discourage a high-risk orientation at their research institutions. The entire area of work for others, including industry, and the DOE's policy on intellectual property rights should be reformulated to encourage the national laboratories to work with the private sector and serve the nation in areas of great importance.

VII. SUMMARY

The Laboratory has served the nation well. In its principal mission, it has helped to secure peace between the superpowers by helping to maintain this nation's deterrent through nuclear weapons technology. It has had a remarkable record of over 40 years of excellence in science and technology.

The Laboratory has evolved over the years into a true national laboratory also serving the nation in crucial areas of conventional weapons, strategic defense, energy and health and contributing to our basic knowledge pool. It is this integration of defense and nondefense technologies, of basic science and technology development, and turning these into end applications that represents a unique resource for this nation.

The Laboratory complements the research and education mission of universities and the product orientation of private industry. It not only engages in world-class research but also has the engineering and development teams to turn research into useful technology for (and with) government or private-sector customers. It concentrates on high-risk, high-potential-payoff research and goal-oriented technology projects that are too big or complex for universities and too risky or uninviting for private industry. It serves the nation with a public-service attitude in areas where the nation's security or the welfare of its people are at stake.

We are concerned that current trends in funding and the increasingly burdensome bureaucracy will erode the special qualities and contributions of our research institutions. However, we have made some recommendations to both the legislative and executive branches of the government that can reverse these trends and make the laboratories even greater assets to the nation's science and technology community and can prepare the nation for the difficult challenges we face in the next decade and beyond. With these changes, we stand prepared to accomplish our vision of the Los Alamos National Laboratory to be a national resource in science and technology capable of solving large, complex problems of great national importance.

Senator BINGAMAN. Thank you very much.

Next is Mr. Irwin Welber, who is the president of Sandia National Laboratories, and has been in that position since February 1986. He came to Sandia after 35 years elsewhere within the AT&T research system, primarily at Bell Laboratories.

We are very pleased to have you here and are anxious to hear your comments.

STATEMENT OF IRWIN WELBER, PRESIDENT OF SANDIA NATIONAL LABORATORIES

Mr. WELBER. Thank you, Senator Bingaman, Senator Glenn, Senator Domenici.

It is a pleasure being here, and it certainly is a pleasure having your attention on this very important topic of the future of the national laboratories.

I would like to refer to your letter inviting me here, Senator Bingaman, in which you said, I am anxious to have your views on how we can sustain and strengthen the laboratories.

I would observe that the lab's future will be assured if we sustain and strengthen national security in the broadest sense.

Sandia Laboratory's mission already includes a broad selection of national security related programs, both energy and defense.

Our nuclear weapons research, development and engineering involves the health and safety of the stockpile as well as new weapons.

We are deeply involved in verification issues, arms control technology, and we recently completed a project for the office of the Secretary of Defense entitled Technical On-Site Inspection Experiment.

This has enabled our negotiators at Geneva to negotiate with a sense of reality with respect to verification of the arms agreements. I will talk more about that shortly.

We are also very concerned with other defense related activities, including advanced conventional munitions. Our energy program involves conservation of renewable energy sources as well as fossil energy and nuclear energy, both fission and fusion, and radioactive waste management.

Our Nation is faced with the fact that nuclear weapons are here, as Sig Hecker said, you cannot put the genie back in the bottle. We at Sandia implement national policy in regard to the U.S. nuclear weapon deterrent, and we remain committed to our role. It would be irresponsible to do otherwise.

We have a serious job to do in maintaining the integrity, safety and reliability of our nuclear weapon stockpile, even if we never develop another nuclear weapon.

As that stockpile ages, and some of it is approaching 30 years, our job is to maintain it both safe and effective, and that becomes more critical as time goes by.

About half of our total nuclear weapons activities are devoted to introducing modern technology into older weapons, replacing aging components and withdrawing samples from the stockpile and monitoring their reliability and safety.

The decline that you observed in nuclear weapon program staffing is generating dangers. The world cannot afford a *Challenger* disaster in our nuclear weapons program.

The technology base resulting from our nuclear weapon research activities must be maintained to prevent technological surprises by our adversaries, even under the aegis of a test ban or arms reduction treaty.

Therefore, as we look to broaden our mission, I see an enduring and continuing responsibility to the nuclear weapon stockpile as long as it exists and is part of our country's national security policy.

We are working closely with the U.S. negotiating teams in considering verification issues related to the arms control proposal, and we expect our programs on arms control and treaty verification to grow.

The more difficult job of verification of arms reduction treaties is yet to be done, and we stand ready to contribute to this process in any way we can.

This technical on-site inspection experiment that I described earlier monitors Soviet missile production. We have studied typical Soviet factories where they manufacture these facilities, and are using their security perimeter to imbed within it modern technology such as fiber optics, and monitoring by means of television signals, entrance and egress of material from those factories.

We are also using satellite communications to report back to this country what is observed. This permits our negotiators to have a sense that what they are negotiating can be achieved.

We are applying our technology base to non-nuclear weapons as well, and we expect this program to grow, to offset dependence on nuclear weapons.

We credit the Armed Services Committees for recognizing the technologies developed in the nuclear weapon program are directly applicable to non-nuclear weapons, as they are to energy research programs.

As has been mentioned, this Nation's future depends on its energy security. It is truly a national security issue. Security that is threatened not only by the prospects of curtailment of supply, but also by the economic impact of huge imports.

Of the U.S. trade deficit for 1986, $34 billion was from oil imports. Specifically, the problem lies in the fact that we as a nation use energy in forms that are very different from those in which we find them in nature.

Almost half the energy that we use in the liquid form, oil, mostly for transportation, while only 2 percent of our domestic supply is liquid.

On the other hand, 94 percent of our domestic resources are solid, mostly coal and shale.

This Nation's huge balance of payment shortfall will continue as long as we use much more liquid fuel than we own, just as we strive to reduce our country's financial deficit, we must strive to reduce our energy deficit.

If we continue at our present rate of usage and import and the price of oil does not go up, by 1995 oil imports will contribute over $100 billion to our trade deficit. That is truly a national security issue.

We at Sandia have proposed long-term growth in our programs in coal sciences, geosciences and combustion sciences as our contribution to the solution of this problem.

We have proposed new programs in geosciences and in coal sciences with the participation of universities, U.S. industries and other national laboratories.

These proposals include research on oil and gas extraction technology, coal liquefaction and clean combustion of coal.

We have already contributed to a possible solution to major pollution problems of smog and acid rain with RAPRENOX, standing for rapid reduction of nitrogen oxides, which facilitates the reduction of soot from diesel engines.

This capability, not coincidentally, grew out of our nuclear weapon technology.

We have also proposed programs to develop a new generation of nuclear fission reactors, having components that are more reliable, drawing on our strengths gained from the nuclear weapon program.

If these programs are funded, we will transfer the resultant technology through alliances with industry and hopefully user friendly.

We have alliances with industry and are proposing more. Our laminar flow clean room technology developed in the early sixties, 25 years ago, for our weapon program, is used worldwide today in hospital operating rooms and in microelectronics manufacturing plants.

Our drill pit technology is currently used to drill 30 percent of the depth of all U.S. oil and gas extraction holes.

We are currently involved with about 25 U.S. companies in either transferring major technologies or participating in joint programs. We will do better and we have to do better.

We are applying our nuclear weapons materials diagnostic techniques to non-intrusive measurements of body chemistry for medical research.

We are also working with the University of New Mexico Medical School to commercialize an implantable radiation dosimeter for cancer treatment.

With concurrence by DOE, we have invited SEMATECH, a consortium of semi-conductor companies, to use our newly constructed radiation hardened integrated circuit facility. This facility, if chosen by SEMATECH, will permit SEMATECH to get started very quickly to regain U.S. preeminence in the integrated circuit technology which we have lost.

Our nuclear weapon microelectronics program will benefit because it depends very importantly on the U.S. base line technology.

We hope we will be successful in this effort.

We thank Senator Domenici and his staff for helping us here.

If I could, I can comment now on the Gramm-Rudman issue. The current Gramm-Rudman-Hollings exercise is, of course, affecting Sandia. We do not know how serious this will be. It is a matter of great concern to us.

We think that the DOE defense program should not be subjected to the extra cuts to accommodate exempted programs within the DOD, and we have proposed that the DOE defense programs be isolated.

We have anticipated reduced funding in defense related activities because of the first Gramm-Rudman-Hollings exercise and have been prudent in planning our laboratory's programs.

However, the largest level of cuts exceeding 10 percent cannot be accommodated and the impact will be serious.

I would like now to comment on a question raised concerning the obstacles that would impede our request to apply Sandia's resources to our national needs.

There are obstacles. We believe that the national interest depends both on precluding technology transfer to adversaries and on increasing technology transfer to U.S. industry.

Present policies, however well intentioned, actually detract from technology security and technology transfer because they force an emphasis on unrestricted dissemination of unclassified information.

This unfortunate state of affairs probably benefits our competitors at least as much as U.S. industry. The solution lies in allowing the laboratories to control the dissemination of unclassified information in order to meet competitive and security objectives.

To do so, we need all the traditional tools of intellectual property, patents, trademarks, copyrights and trade secrets. Trade secrets are particularly important because they allow us to disseminate information selectively.

Existing procedures with respect to patents involve case by case review by DOE and are thus inherently slow. In this business, speed is of the essence.

I would like to conclude now with some remarks about the significant barriers to the successful management of Sandia Laboratories. This would be the repeal of section 1631 of the 1985 Defense Authorization Act, otherwise known as the Warner amendment.

The Warner amendment limits claims due to exposure to atmospheric atomic tests for the fifties and sixties to actions against the Federal Government. It recognizes that in law and in fact the Federal Government was solely responsible for conducting atmospheric testing and that the national laboratories, particularly Los Alamos and Sandia, were serving as instrumentalities of the Federal Government.

The repeal of this amendment would make it very difficult for those like myself who manage Sandia and the scientists who work here to devote our full attention to achieving success in our national programs.

Repeal would also make it very difficult for AT&T to continue its contract with the DOE to manage Sandia for no profit or no fee. AT&T support has been an important contributor to Sandia's success.

Repeal is not the only answer for veterans who feel that their claims have not been adequately addressed. HR 1811 which has passed the House, and Senator Cranston's bill S. 9, and Senator Domenici's bill S. 453, significantly improve the relief available to atomic veterans through the VA.

Veterans groups say they prefer this litigation against the national laboratories. We encourage the Senate to support such measures and oppose repeal of 1631.

Gentlemen, I truly appreciate the interest and concern you have for the future role of the national labs and I repeat, I believe the lab's future will be assured if it is permitted to strengthen and sustain national security in the broadest sense.

Thank you.

Senator **BINGAMAN**. Thank you very much.

The final witness in this panel is Dr. James Davis, who is the executive officer at Lawrence Livermore National Laboratory.

Dr. Davis assumed his current position earlier this year, after working on various laser programs in the laboratory over the last decade.

We are glad to have you in New Mexico and look forward to your testimony.

STATEMENT OF DR. JAMES I. DAVIS, EXECUTIVE OFFICER OF LAWRENCE LIVERMORE NATIONAL LABORATORY

Dr. **DAVIS**. Thank you, Mr. Chairman.

Mr. Chairman, Senator Glenn, Senator Domenici, we from Lawrence Livermore Lab appreciate the opportunity to participate in this hearing.

I would like to thank you on behalf of the laboratory for this opportunity to comment on the future of our lab.

Before I try to respond to Senator Bingaman's specific questions, what I would like to do is read our mission statement, and in quotes, our mission is to function as a national resource of scientific and technical capability for the Nation's defense programs and, as appropriate, for other programs of national interest.

Now, the "as appropriate" was defined actually at the founding of the laboratory in 1952, because at that time we initiated a major program in fusion energy contemporaneously with the initiation of the nuclear weapons program.

Much of what I will say, and I can make it a little brief because of that, Sig Hecker has already stated with regard to the nuclear weapons programs.

We see that as our primary mission, even though there will be fewer nuclear weapons, we simply see an evolution in the mission, not a change or a moving away from the mission.

We need to ensure that the existing arsenal is reliable, provide replacements for aging weapons, prevent surprise by nuclear weapon innovations, and the evolution that we see in continuing support for arms control and the development and verification and surveillance technology.

Another area that we see evolving out of the changing structure of the new weapons program is the development of more advanced simulation and computational capabilities. I would say that would be true at all the labs, I would think.

Now, in the "as appropriate" in our mission statement, I believe Senator Glenn, Senator Domenici and Senator Bingaman have stated these factors, and I believe we are pretty much in coincidence, in that we regard the national security as the basis for broadening our mission.

We include in that economic as well as military security. So we are sensitive to that and we are trying to broaden our mission to take both of those factors into account.

Financial risk, technical risk, long pay-back, and significant scale are obvious factors that should be included. We think we bring a unique, multidisciplinary capability to new programs.

We have unique physical facilities and an infrastructure, our abilities in metrology, diagnostics, and so forth. Those are some of the key characteristics that we see any new program must satisfy if we are going to broaden our mission to include them.

Now, some of the national programs that are currently ongoing that meet those criteria, in addition to nuclear weapons, are laser isotope separation, inertial confinement fusion, magnetic fusion, beam research, biomedical research, which is another program that grew out of our nuclear weapons activity in the sixties.

Then some emerging programs that we see at the lab, though small, may have a potential for becoming much larger and more important programs, and that's global atmospheric and environmental modeling.

We have a program known as ARAC, Atmospheric Release Advisory Capability, and we were very active in the tracking of the cloud from Chernobyl.

We see particle beam weapons as a major activity in our future, advancement of accelerator technology. Tactical anti-sensor weapons, perhaps to put this in context, the recent illumination of one or our pilots using lasers off the coast of Hawaii would be an example of the types of weapons we are dealing with here.

Supercomputers, we see that as we can contribute to the technology of those through some of our laser pantography efforts, which is the writing of circuits and development of special chips.

Strategic communications we are involved in. Advanced non-nuclear munitions have already been mentioned. These are all areas that we see emerging and offering a real potential for us to expand our mission.

Another way in which we develop new initiatives at the laboratory is an area known as director's initiatives, where the director of the laboratory allocates some substantial sum of money to new ideas.

I will read here the four or five major ones that are ongoing for the coming year. One is the compact torus, where we are trying to generate much higher magnetic fields for magnetic fusion, so that these magnetic fusion machines can be small enough and possibly economical in the future.

Large crystal growth is an area we have the director's initiative in. It turns out that it is not Western Europe or Japan that is ahead of us in that area, but the Peoples Republic of China is ahead of us.

These crystals are important in all electro-optic devices and lasers. They are important to our tactical weapons development activities.

Infrared diode array development we are participating in. That has been largely pushed forward in many areas by industry. We think we can contribute there in very specialized ways that are important for strategic communications.

High gradiant induction accelerators, a technology that started in the sixties at Livermore that is now becoming prominent in beam weapons and in free electron laser programs.

Another area of surveillance under the director's initiative is high resolution imaging. There are many other smaller projects that are funded at the discretion of the director of the laboratory.

Now, moving towards some of the specific items in your letter, we emphasize a role somewhat different from industry and the university, and many of you have already commented on it. I do not have much to add to that. I think we see it exactly the same way.

We have a division of applied science at our laboratory that is a branch of the University of California, Davis, and that has been ongoing for some time now. And students actually live there at that site and work at the laboratory using the facilities.

We collaborate with universities in special institutes and those that have been very effective. Then, obviously, very early in the research and development we have many, many involvements with universities.

In the case of industry, we are collaborating with industry across the board, and I will give you some highlights of that in a few moments.

We do everything from engineering components to full spectrum program collaboration.

To illustrate some examples of that, of course, they break into different types of categories. The weapons program is collaborated through integrated contractors and that format has been very effective.

The laser isotope separation program has integrated laboratory-industry teams, where an industry lives at the laboratory. In that case it is Martin Marietta and Westinghouse.

That is more along the lines of the traditional integrated contractors.

Other examples where we work with small entrepreneurial companies would be the transfer of inertial confinement fusion laser technology through the International Lamp Corporation, a small entrepreneurial company on the west coast.

The free electron laser and magnetic fusion programs are teamed with TRW and GA Technologies, and that is a teaming arrangement with those corporations who live at our site and work with our organizations and systematically technology is transferred.

In the case of new average power solid state lasers for tactical anti-sensor weapons, Hughes, Martin Marietta, Litton, General Dynamics and Varo are collaborating with the laboratory.

Another area that is much different from these hardware type programs is software, and we have developed software for computer aided logic design and that has been—that software package has been transferred to companies, high-tech companies in the Bay area, and are in sales up to some $60 million, $70 million through that transfer alone.

There are many other companies and spin-offs and other collaborative efforts that I can list, but I will go on.

So we believe that our technology transfer through these various mechanisms that we have used has worked reasonably well. We do not think it is adequate for the future, it is a problem, and for many reasons that Senator Domenici mentioned and we feel that some improvements are required there.

Now, our perception of this is, much of the legislation, the Dole-Bayh, Stevenson-Wydler Public Law 99-502 and the Executive order of April 1987, have gone a long way in helping us make the kind of technology transfer we want.

We still see major disincentives to these thrusts, and the disincentives get back to something that I think Sig Hecker referred to earlier in his general interpretations of these laws, that tend to put them in sort of a molasses and slow the process down.

Now, there is legitimate reason that that happens, the balance between security nonproliferation and getting the technology out to industry.

It is that balancing act that creates the high viscosity of getting these things to happen, even though the laws are in place and they are subsequently interpreted against other regulations.

So we see that as one of the major obstacles to getting the kind of enhanced collaboration that we think you want and we want.

Another question you asked——

Senator DOMENICI. Is that improving?

Dr. DAVIS. Well, we just nogotiated our new contract with DOE and we are in the process, since it is so new, of interpreting that and trying to determine where we really stand. And so I really cannot give a much better answer than that at this point. But we are in negotiations at this point.

Senator DOMENICI. Thank you, Mr. Chairman.

Dr. DAVIS. Another question Senator Bingaman's letter raised was what about sustaining of laboratories and what things have been most effective in the past, and some of these I have already mentioned. I will mention them again.

One is the block funding of major national programs and major missions. If we are salami sliced into small pieces and we have to manage all those small pieces without the discretion to initiate promising new concepts, to respond to the research as we run into problems or run into solutions, then that will not be very effective.

Then the ability to utilize funding for all phases of research and development demonstration, we very much want to be sure that what has happened in DOE labs in the past continues to happen, that we do not break our money into 6.1, 6.2, 6.3A, 6.3B, and so forth.

So we hope that does not happen as we move to work with the Department of Defense.

Now, in order to strengthen the laboratory, we have a few points that we wanted to make, and there are many to be made, is the 2-year overlapping authorization and budget cycle would be very useful, we think.

We seem to spend a great deal of time closing our books at the end of the year and restarting the process, and if we can get that cleaned up a bit, I think it would be very helpful.

Senator BINGAMAN. I think the reason everybody up here is grinning is we can't even seem to do it 1 year at a time. [Laughter.] Let alone 2 years.

Dr. DAVIS. Another item that would be useful in strengthening our ability to function would be to allow the laboratories to reprogram funds between operating and equipment.

The notion of the color of money in the context of national labs has been something that we feel is not appropriate, possibly, and also does not allow us to balance manpower versus buying an oscilloscope, or whatever, in an appropriate way.

Better support from DOE in striking collaborative agreements with industry, what I mentioned earlier, that would strengthen our laboratory, we believe, because we believe that it is important to do that.

Again, I think DOE has legitimate concerns that they are trying to deal with, but nonetheless, it definitely needs to be strengthened and implemented more vigorously.

Now, if we are going to work with the DOD in a more aggressive way, I think greater flexibility in DOD management procedures would be very helpful.

Again, this is mission responsibility, block funding, and an ability to fund all phases of the RD&D as we currently have with the Department of Energy.

Those would be the items that we feel would be most important in strengthening our laboratory.

The last item you raised in your letter was the impacts of Gramm-Rudman. Obviously, we see a potential reduction in force, yet it is not impossible to work at the 10 percent level.

The depths of that reduction in force really would be sized on the basis of what we think fiscal year 1989 would bring. In other words, if we are just going to have a little ripple here in cut and we see a bright future in 1989, then of course we might try to avoid a layoff and weather the storm.

If it becomes clear as a result of the conference that is going on now between the Congress and the President, that fiscal year 1989 is going to be even worse, then we will probably make a deep cut in our laboratory and restructure the work force to anticipate a continual reduction in force in the future.

So I believe the points that I made a moment ago with regard to strengthening our laboratory is really my summary, and I will leave it at that.

Again, we appreciate the opportunity to come here today and present our views.

Thank you very much.

[The summary remarks of Dr. James I. Davis, as well as comments submitted by Dr. Roger Batzel, Director of Lawrence Livermore National Laboratory and also comments from Herman Postma, Director of Oak Ridge National Laboratory follow:]

Summary Remarks

James I. Davis
Lawrence Livermore National Laboratory

Lawrence Livermore National Laboratory Testimony to the Senate Subcommittee on Defense Industry and Technology regarding:

- Potential impacts on LLNL's primary mission
  - Nuclear Weapons RDT&E
- Opportunities to broaden to other national missions
- Obstacles to broadening
- Sustaining and strengthening national programs
- Potential impact of sequestration

Nuclear weapon research, development and test remain LLNL's primary mission

Nuclear weapon program objectives

- Ensure that existing arsenal is reliable
- Provide replacements for aging weapons
- Improve safety and security against current world hazards
- Prevent surprise by nuclear weapon innovations
- Support arms control
- Develop verification and surveillance technology
- Develop advanced simulation and computational capabilities

LLNL will continue to broaden its mission responsibility for other national programs with the following characteristics

- Critical importance to the national security:
  Including economic as well as military security
- Financial risk:
  Financial loss could not be sustained by industry if project fails
- Technical risk:
  Reach well beyond (≥ 10X) current industrial capability
- Long pay-back:
  Period well beyond normal industrial horizon (~ 5 years)
- Significant scale:
  As measured by magnitude of capital risk
- Multidisciplinary:
  As contrasted with departmental compartmentalization in universities
- Require our physical facilities and infrastructure:
  Unique metrology, diagnostics, and test facilities combined with special mix of staff skills

LLNL is continuing to broaden its mission

Major national programs currently on-going

- Laser Isotope Separation
- Inertial Confinement Fusion
- Magnetic Fusion
- Beam Research (Free Electron Laser)
- Biomedical Research

Some emerging programs

- Global Atmospheric/Environmental Modeling
- Particle Beam Weapons
- Tactical Anti-Sensor Weapons
- Supercomputers
- Strategic Communications
- Advanced Non-Nuclear Munitions

Director's Initiatives in Research and Development include:

- Compact Torus (Magnetic Fusion)
- Large Crystal Growth (Inertial Confinement Fusion and Non-Nuclear Weapon Systems)
- Infrared Diode Array Development (Strategic Communications)
- High Gradient Induction Linac (Beam Weapons and Free Electron Laser)
- High Resolution Imaging (Surveillance Systems)

In addition, over 50 other small project, discipline, or technology initiatives have been awarded grants under our Institutional Research and Development Program.

In addition to its own staff and facilities LLNL utilizes

- Universities for:
  - Consulting
  - Research and development
  - Project and institute collaboration
- Industry for:
  - Engineering
  - Material and component development
  - Prototype and subsystem development
  - Material, component, subsystem manufacturing
  - Laboratory and field operations
  - Full spectrum program collaboration

LLNL has a tradition of successful industrial collaboration

Programs	Primary Contractors
Weapons Program has 35 years of effective transfer	Bendix, Rockwell, Martin Marietta, Monsanto, Mason
Laser Isotope Separation has integrated Laboratory/Industry teams	Martin Marietta, Westinghouse*
Inertial Confinement Fusion commercialized its laser technology	ILC*
Free Electron Laser and Magnetic Fusion Programs teamed with	TRW, GA Technologies*
New Average Power Solid-State Laser Programs are cultivating new Industrial partners	Hughes, Martin Marietta, Litton, General Dynamics, Varo*
Software for computer aided logic design	Valid Logic Systems, Daisy Systems

*Many other contractors in addition to these primary contractors are now marketing specialized products as a result of involvement in these programs.

Obstacles to increased industrial collaboration still exist

- Dole-Bayh gave U.C. the right to acquire patents, a necessary step allowing U.C./Industry ventures
- Stevenson-Wydler encouraged DOE and the Laboratory to allocate funds and set up office for Technology Transfer
- Public Law 995-02 amended Stevenson-Wydler to allow Laboratory Directors to enter agreements with Industry
- Executive Order 12591 (April 1987) encouraged the vigorous implementation of these three laws

Disincentives to this thrust are:

- Interpretation that PL99-502 does not apply to GOCOs, only GOGOs
- Imposition of added cost factors over actual cost plus overhead on industrial sponsors (full cost recovery)
- Requirement that U.C. pay for patent pursuit
- Direct involvement and required concurrence by DOE in details of contract between U.C. and Industry

In order to sustain the technical strength of the Laboratory, we will continue to need:

- Block funding of major national programs
- Ability to utilize funding for all phases of RD&D
- Discretion to initiate promising concept exploration at the research level

In order to strengthen the Laboratory, we could benefit from:

- 2 year authorization and budget cycle
- Ability of LLNL to reprogram funds (operating and equipment)
- Better support from DOE in striking collaborative agreements with Industry
    - Full implementation of Dole-Bayh, Stevenson-Wydler, and Public Law 99-502
    - Mitigation of administrative impediments
- Greater flexibility in DOD management procedures in relation to DOE Laboratories
    - Mission responsibility
    - Block funding
    - Ability to fund all phases of RD&D (as with DOE)

Impacts of sequestration

- Potential reduction in force
  - Depends on depth of FY88 cut and anticipated FY89 funding
  - Could require restructuring of work force
  - Would cut into capability of technical staff
- Programs will obviously slow down and milestones will be delayed
- New initiatives will be slowed
- On-going revitalization programs will be slowed
  - New staff to maintain a future
  - Facility rehabilitation
- General preoccupation with non-technical issues

COMMENTS BY

DR. ROGER BATZEL

LAWRENCE LIVERMORE NATIONAL LABORATORY

THE MISSION AND ROLES OF THE U.S. NUCLEAR WEAPONS LABORATORIES

November 7, 1987*

This paper reviews the roles of the National Laboratories and, in particular, the role of the Lawrence Livermore National Laboratory (LLNL).

THE LABORATORY AND ITS PROGRAMS

The Lawrence Livermore National Laboratory is a large, multiprogram and multidisciplinary institution which performs research in a wide variety of fields ranging from defense to the environment. The Laboratory is operated by the University of California for the U.S. Department of Energy, but performs reimbursable research for other agencies of Federal and State Government as well.

Founded in 1952 by Professor Ernest O. Lawrence and others from the Radiation Laboratory in Berkeley, California, the Lawrence Livermore Laboratory was established to be the second of two nuclear weapon development laboratories (along with Los Alamos in New Mexico). In 1980, the U.S. Congress added the word "National" to the names of these Laboratories, to emphasize their significance as national resources, serving the Nation as a whole.

The Laboratory was founded in the context of two key decisions that provided for a new type of national research institution. First, the Atomic Energy Act established independent, civilian control of atomic energy and related defense capabilities. Second, the AEC established a new method of Federal contracting which allowed the expertise and flexibility of universities and industry to be applied to high priority Government programs.

Established as a nuclear weapons laboratory, almost all of the Laboratory's early research was defense related, a notable exception being its very early and continuing work on magnetic fusion. Today, the major activity of the Laboratory remains nuclear weapons research although this work now comprises less than half our total effort.

Including other defense-related research, such as arms control and treaty verification and reimbursable work for the Department of Defense and SDIO, about 80% of the Laboratory is involved in national defense issues. This commitment to national defense is expected to continue for the foreseeable futur. The remaining 20% of the Laboratory's programs address National problems in the areas of energy and the environment

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*Revised from a briefing paper originally presented on April 22, 1987, to the Subcommittee on Energy and Water Development of the Senate Appropriations Committee.

For example, the Laboratory has two active programs in fusion research, one in magnetic fusion and the other in laser fusion. Both approaches seek to demonstrate the possibility of clean and safe power by fusing the hydrogen isotopes found in ordinary water. A major research effort in isotope separation uses high power, tunable laser beams to select and excite desired isotopes from a low-grade feed stream. This work has been demonstrated on an engineering scale for enriching the isotopes of uranium as fuel for reactors producing electrical power. Of course, this technology is also being applied to separate and upgrade plutonium for defense purposes.

Another major research area for the Laboratory is in biomedical and environmental science. This biomedical research deals mainly with the detection and evaluation of genetic mutations and cancers. The environmental work studies aquatic and terrestrial ecology, the transport of pollutants and the development of sensitive and sophisticated instruments for identifying and tracking hazardous materials.

Collectively, the Laboratory's programs represent a significant resource for the Nation. Its research programs, especially in defense, support much new technology. The applications go far beyond the original scope of the research. For example, supercomputer development, supported by nuclear weapons research has opened new realms of scientific computing--solving complex problems which otherwise would be intractable. The programming techniques which are a part of this research have been applied to the automated design of future computers. Similarly, a new development in laser pantography has dramatic applications in speeding and reducing the costs of wafer scale integrated electronic circuits.

Altogether the Laboratory's programs were funded at about $956 million in FY 1987. Of this total, about $834 million is in operating expenses, the balance in capital equipment and construction.

The historical Federal approach to funding the Laboratory's major mission has its origins in the policies of the Atomic Energy Commission and has been sustained under ERDA and the DOE.

Nuclear weapons research development and testing, the Laboratory's largest, single program, was funded at about $325 million in FY 1987. Steady funding for this work provides stability for the Laboratory overall and helps sustain the Laboratory as a National resource even when smaller, more volatile programs lose National support.

If this core program is reduced, it tends to affect the Laboratory as a whole. Reductions in our weapons work also reduce administrative and indirect program support Laboratory wide which, in turn, impact the flexibility of other, smaller programs to contribute.

THE IMPORTANCE OF THE LABORATORY'S MISSION

The mission of the Lawrence Livermore National Laboratory is brief and expresses a framework for continuity and clarity of purpose:

> "Our mission is to function as a national resource of scientific and technical capability for the nation's defense programs and, as appropriate, for other programs of national interest."

Clearly stated is the Laboratory's first responsibility to national security. Research on nuclear weapons is the reason the Laboratory was created. Also acknowledged is the Laboratory's responsibility to the country's broader purposes and problems where the Laboratory has the special skills or facilities to make unique contributions.

The way in which a statement of mission is applied is as important as the definition it contains. The Laboratory's role is to invent, understand and develop new technologies with significant payoffs to national needs. To stimulate technological development there is a special program of internal research and development initiatives to help researchers explore possibilities that may not fit within the framework of established programs. However, full-scale research programs are examined and chosen carefully, in the light of the following:

- o The research addresses an important national need or issue;
- o Unique LLNL skills, facilities, or other special capabilities are required;
- o The research complements major laboratory programs, and;
- o The research will NOT have an adverse impact upon critical DOE and Laboratory interests in national defense--both programmatic and institutional.

These criteria are applied in the context of two fundamental principles: (1) the Laboratory is a public sector institution, carrying forward a long-established tradition of public service and (2) the Laboratory is a not-for-profit institution.

THE SPECIAL LABORATORY ROLE IN NATIONAL SECURITY

The Lawrence Livermore National Laboratory and the Los Alamos National Laboratory (LANL) have a special role in national security. Generally this role is to visualize, understand and develop new technologies which provide new options for national policy. In nuclear weapons research and development, the Laboratory role takes on four specific aspects: (1) to assure that the weapons in the Nation's nuclear arsenal are safe and reliable, (2) to develop options for replacing aging weapons with modern military systems, (3) to develop improved safety and security features for nuclear weapons, and (4) to guard against technical surprise in new weapons concepts. This last role includes understanding what is possible in many defense areas, whether this country chooses to use it or not, in order that we are not surprised by our adversaries. In large measures, the country's nuclear weapons capability depends on the excellence of these two laboratories. The technology base for nuclear weapons exists in these laboratories and is not available elsewhere in the U.S. The technology deals with processes and conditions which cannot be duplicated in laboratory experiments.

In this area, it is vital that the weapons design Laboratories remain competitive with their counterpart laboratories in the Soviet Union. Those Soviet laboratories have about twice the resources in physical plant, equipment and people as Lawrence Livermore and Los Alamos. From their publications in the open literature, it is known that Soviet scientists are top-notch and represent a formidable capability, given adequate resources and management flexibility.

THE IMPORTANCE OF QUALITY AND FLEXIBILITY

The capabilities of the National Laboratories depend almost entirely upon the excellence of the technical staff. This is a familiar observation, but maintaining the required level of excellence requires careful management, constant attention, and considerable resources.

Equally important is flexibility. Very early, the weapons laboratories learned how to adjust their scientific and engineering resources to adapt to the varying requirements of the nuclear weapons design and development cycle. As the Laboratories broadened the scope of their programs, the possibilities as well as the the importance of flexibility increased. For example, LLNL's studies of abnormalities in human genes have been assisted greatly by the presence at the laboratory of competence in lasers and computations which are not usual in specialized biological research laboratories. At universities, multidisciplinary projects are not easy to organize or manage. University research projects are usually organized around one discipline or another. At LLNL, large, multidisciplinary projects are routine. Further, advances in one program frequently lead to advances, computer models, technology or equipment in other programs. Synergistic developments between multidisciplinary programs are a special benefit of our approach.

A certain critical mass is essential if a multidisciplinary research organization is to be successful on a sustained basis. It is not just a question of overall size. Each programmatic component must include a certain degree of diversity, a mix of talents and capabilities. A large number of small, independent projects can be a management burden whereas a few, larger programs, with technologies that complement a major mission, can lead to many special achievements.

The Atomic Vapor Laser Isotope Separation program at Livermore is an excellent demonstration of the advantages of a clear mission, an excellent staff, and flexibility. The initial applications--enrichment of uranium and purification of plutonium--related closely to the Laboratory mission. The project was based upon the exceptional excellence of a diversified, very experienced staff in the laser programs. The flexibility of the Laboratory's management and engineering capabilities and its experience with large-scale prototype programs made it possible to advance this technology under tight time constraints. The technology is now at a stage of transfer to a production organization. The potential benefits for U.S. competitiveness, in other applications as well as in uranium separation, are substantial.

THE NATIONAL LABORATORIES AND U.S. COMPETITIVENESS

When LLNL was founded, competitiveness for the United States was defined primarily in terms of the competition between the U.S. and the USSR in nuclear weapons technology. Assuring that the United States continues to be second to none in nuclear weapons technology remains the Laboratory's first priority. In 1952, however, and even in 1962 and 1972, it could be taken for granted that the United States had a substantial lead in most other areas of advanced technology---a lead which expressed itself in a U.S. advantage in international trade.

That is no longer the case. Other countries now equal and frequently surpass U.S. levels in many key technologies. This is reflected in U.S. trade deficit and in the decline in manufacturing industries. It is natural to ask: How can the national laboratories contribute to U.S. economic competitiveness? The record of accomplishment is impressive. In a large, multiprogram National Laboratory, one finds extensive interaction between laboratory researchers and their peers and colleagues at universities, other national laboratories, and private industry. These interactions frequently yield significant contributions in areas outside the original focus of the Laboratory programs. Several of LLNL's successes in this area are documented in what follows:

SUPERCOMPUTER DEVELOPMENT

The benefits of interaction between nuclear weapons technology and other technology have been demonstrated clearly in the contributions of LLNL and LANL to the development of supercomputing. For three decades, computational specialists at these laboratories have collaborated closely with the manufacturers of high-performance computers. This long, fruitful collaboration has resulted in important practical advances in technology related to computer operating systems, a wide variety of software applications for engineering and other uses, and in improvements in workstations and minicomputers. A large part of these results are available to other American researchers and to U.S. companies.

This has been of fundamental importance to the basic mission of the DOE weapons laboratories. Supercomputers are an essential tool in the quest to understand more completely the complex physics of nuclear explosions.

The software and other technology developed at the National Laboratories is also playing a significant role in the current rapid expansion of supercomputing in the United States. This has a direct impact upon productivity and competitiveness in many industries, including aerospace, fossil fuels, automobile design, chemistry, the design of semiconductor chips and computer systems, and the development of new medicines. The contributions of the National Laboratories are also laying a foundation for future technology. The DOE's National Magnetic Fusion Energy Computer Center, operated by LLNL, pioneered networking strategies and software which are now used by several of the five new national supercomputing centers supported by the National Science Foundation. These new centers interact with private industry in addition to providing facilities for university-based research and promoting training in supercomputing. In the past, the National Laboratories have contributed to the substantial lead the United States has maintained in supercomputers. Although other countries are now entering this market place, the National Laboratories will continue to be of great value in preserving a competitive edge for the United States.

ELECTRON BEAM RESEARCH, COMPUTER DESIGN, AND PRECISION ENGINEERING

Recent advances at LLNL in electron beam research have made linear accelerators feasible for industrial use. While linear induction accelerator technology is being supported by the Strategic Defense Initiative Organization for possible application to ground based laser defense, it also will have many other applications. For example, these portable and reliable machines are capable of producing a beam that can convert the air pollutants causing acid rain into fertilizer. They can also be used to sterilize medical equipment and to preserve food. LLNL has received many inquiries from companies interested in manufacturing these machines and held an industrial briefing in March of 1985.

LLNL developed and used automated computer design software called Structured Computer-Aided Logic Design (SCALD) in the program to design an advanced supercomputer system faster and more powerful than any existing today. A working model of this special computer was built in six months instead of the five years or more the project would have taken without the software. This software has been made available to several hundred interested United States' commercial, academic and government users. Over twenty companies have been created to market SCALD and assist in its implementation, and two of the largest ones are Daisy Systems and Valid Logic Systems. Daisy had about $41 million and Valid about $23 million in sales last year--each up about 400% from the earlier year.

The commercialization of the Laboratory's precision engineering program demonstrates how the investment of research dollars can increase productivity, involve industry, and result in the development of new technologies--all essential to improving national competitiveness.

In support of DOE's nuclear fusion and nuclear weapons fabrication programs, LLNL has become a leader in precision engineering--the design, fabrication, and inspection of highly precise mechanical parts and devices. Prominent among the precision manufacturing techniques LLNL has advanced are diamond-turning machines, which use diamond cutting tools to machine surfaces with extreme precision. LLNL also developed the first computer-controlled diamond-turning machines, which became the model for the private sector. Many of the features that were developed for past generations of LLNL machines are now standard.

Over the years, LLNL has demonstrated its diamond turning technology across the nation through conferences, meetings, published papers, and private consultations with industry leaders. U.S. industry now produces diamond-turned products which include laser optics parts; molds for plastic contact lenses; computer memory disks; photocopier cylinders; video tape recorders; cameras; and laser optical disk players. Industry has found significant gains in product design, product quality, and production rates with the application of precision engineering methodologies.

ENHANCING LABORATORY CONTRIBUTIONS TO U.S. COMPETITIVENESS

The Department of Energy and the Congress, as well as the Laboratory, have helped make these accomplishments possible but more can be done to increase the laboratories' contributions to U.S. international competitiveness and to the industrial base of the United States.

This will require additional efforts by all participants---Industry, the Department of Energy, Congress, as well as the National Laboratories. Changes in structure and attitudes are needed. The Stevenson-Wydler Act as currently amended and the Bayh-Dole patent legislation should be fully implemented. The University of California needs full title to patents, copyrights, technical data, and tangible research property such as biological cell lines, in order to deal flexibly with organizations which can commercialize these valuable resources and give preferential treatment to U.S. companies. Barriers to these agreements need to be eliminated; for example, the DOE added cost factor for industrial sponsors, the requirement that the government be reimbursed by the University for patent costs, and the unwieldy system requiring an unacceptable level of effort and time on the part of industry interested in technology transfer.

The implementation of current laws and the removal of bureautic barriers to technology transfer are necessary but not sufficient for the full utilization of America's creativity. U.S. industry must become more aware that the National Laboratories have something that can be useful and profitable to them. This will require individual and institutional efforts and the building of trust.

HOW CAN THE LABORATORIES BE MORE EFFECTIVE?

No discussion of the role of the National Laboratories, their contributions to the nation, and their future as a national resource is complete without a look at the problems they face--both those caused by an era of constrained funding and those caused by policy decisions which limit our effectiveness. Improved and accelerated contributions to national competitiveness are certainly important, but problems also impinge upon the Laboratories' basic missions. Once again, the search for solutions must depend upon a continuing collaboration between the Congress, the Department of Energy, and the Laboratories.

In 1982, the Multiprogram Laboratory Panel of the Energy Research Advisory Board released a study which assessed the appropriate roles and missions of the Department of Energy's Laboratories, their capabilities, and the effect of the DOE's policies and procedures on the effectiveness of the Laboratories. The Panel found the National Laboratories to be an "impressive national research and development asset". While the Panel reaffirmed the importance of the Laboratories' efforts in reaching the Nation's goals in science and engineering, the report also identified a number of problems that are still unsolved.

The ability---and freedom---to concentrate upon long-range, high-risk, high potential gain research are major strengths of the National Laboratories. Such projects are difficult to carry forward to success when funding is uncertain, suffers severe oscillations, or vanishes when a technology is about to pay off.

In the area of funding, the ERAB Panel urged a two-year appropriation by Congress with carry over funding to stabilize laboratory planning and program execution. It emphasized the need for laboratory directors to have substantially more flexibility within overall budgets and broad program guidelines to reprogram resources and to initiate programs in response to research and development opportunities. The current restrictions on "work for others" was seen as hampering creativity and interfering with technology transfer. The Panel found that the Laboratories are overburdened with detailed reporting and other paperwork requirements which divert resources from their research and development missions. Some of DOE's management decisions were seen as restrictive and counterproductive such as the restrictions on cooperative efforts with industry and the barriers imposed on the granting of patents and commercialization of non-weapon related inventions. Of course, proper consideration must be given to protecting national security information.

A FEDERAL PARTNERSHIP

In developing the management contract which governs the relationship between the Federal Government and the Laboratories, the Atomic Energy Commission put primary emphasis on the achievement of program objectives while maintaining as much flexibility as possible in the approaches to specific situations. The contract for LLNL describes our partnership this way:

> "It is the purpose of this agreement to encourage basic scientific progress and to assure adequate technical accomplishment in the interest of the national defense and public welfare. It is expressly understood that this agreement is subject to the paramount objective of assuring the common defense and security of the United States. It is the intent of the DOE and the University that this agreement shall be carried on in a spirit of friendly cooperation with a maximum of effort and common sense in achieving their common objectives."

The University of California has just concluded a two-year period of negotiations with the DOE to renew the five-year contract for the operation of the Lawrence Livermore National Laboratory, Los Alamos National Laboratory, and the Lawrence Berkeley Laboratory. During these negotiations it was important to reflect on those features of the current contract arrangement which give our research vitality and flexibility.

THE NATIONAL LABORATORIES: AN INVESTMENT IN THE FUTURE

In addition to meeting specific mission requirements, the contributions of the National Laboratories to our nation's competitiveness can be evaluated by looking at research funding as an investment. A recent Office of Technology Assessment report looked at both the economic and non-economic rewards expected from a good investment of Federal research dollars. On the economic side, OTA considered the productivity changes that result from government funded R&D, the benefits of technology transfer of specific inventions, and the percentage of new technologies developed by industry that are based on the use of licenses and patents granted by government agencies and their contractors. On the non-economic side, there are the opportunities that government sponsored research provides to graduate education and university programs, the contributions scientists make to the "state of the art" in science and engineering, and the fostering of science that comes from bringing together highly motivated and creative people in an environment that encourages and protects high-risk projects that offer great potential for the future.

THE FUTURE OF THE NATIONAL LABORATORIES

One of the difficulties of administering a scientific establishment is the constant tension between the need for prudent planning and the difficulty of predicting future requirements. The headlines of the past few months illustrate this dilemma. The discovery of materials capable of superconductivity at exceptionally high temperatures offers a wide range of electronics and energy applications. A new supernova is confronting astrophysicists with unexpected phenomena--which could have implications for other research in physics, including research at LLNL. The pace of biological research is equally exciting. The multiprogram National Laboratories are a critical resource in the nation's capability to pursue new scientific and technological opportunities as soon as they are identified. It is essential to maintain a technological base which makes it possible to imagine, analyze, and, if appropriate, pursue new opportunities as they come along. Many important new developments require a broad response, involving many disciplines. A multiprogram laboratory can mobilize quickly, from within its own resources, well-qualified staff and existing technical capabilities across a broad front.

Multidisciplinary National Laboratories are important institutional complements to universities and industry. They bridge the gap between basic research at universities and product development in industry. In the Laboratories, basic and applied research can proceed without the competing responsibility for teaching. In industry, research is constrained by relatively near term goals for a quick return on investment. National Laboratories can undertake the long range research, especially in high risk areas, that is generally outside the scope of industrial research.

While the capabilities of the National Laboratories are a special national resource, to achieve our best for the nation, they must work in partnership with all of the Federal Government, the Executive Branch agencies that sponsor research, and the Congress which authorizes and appropriates its resources.

The nuclear weapons laboratories have a special responsibility to the country through their national security roles. The future of these Laboratories depends on the quality and capabilities of people, people in research, and people in government. It is a major tribute to the people of the National Laboratories that they are able to perform well across such a wide spectrum of programs. With proper support and operational flexibility, they should continue to be able to make important contributions in their areas of special expertise. This will be fundamental to their future, to the reputation of U.S. technology world-wide, and to the security of the United States.

Written Testimony Before the
Subcommittee on Defense Industry and Technology
by
Herman Postma, Director
Oak Ridge National Laboratory
Albuquerque, New Mexico
November 7, 1987

As Director of the Oak Ridge National Laboratory, which is operated for the Department of Energy (DOE) by Martin Marietta Energy Systems, Inc., a subsidiary of Martin Marietta Corporation of Bethesda, Maryland, I appreciate the kindness of the committee in allowing me to present written testimony in lieu of appearing before you in person. The opinions in this testimony are strictly my own and not those of the Department of Energy or Martin Marietta Energy Systems, Inc. I have been the Director of the Oak Ridge National Laboratory for 14 years and during that time have served on a number of national committees associated with reviews of national laboratories; this testimony is a result of that perspective.

It is important to note that DOE laboratories are among the best research organizations in the world. They were created at different times for different reasons and are operated under a system in which government-owned facilities are operated by a variety of contractor organizations. These laboratories have been examined by reviews in the U.S., as well as by other governments; the concept has been copied in various forms throughout the world. Collectively they are the most impressive research organizations in the world, and individually they excel in different areas, each having different missions, but all are a source of extreme national pride.

Missions

The missions of the national laboratories must necessarily follow the missions of the parent agency--the Department of Energy. As that emphasis has changed--and it has several times in the last decade--the research emphasis at the laboratories has also changed. At the same time credit must be given to the laboratories for having developed the rationale, technology, scientific advances, and the very opportunities that were needed for that change to occur. Yet, we are again at another threshold in which each national laboratory of DOE must become even more "national" in scope and not confined by a narrow perspective even though the DOE missions must remain the primary focus. The confluence of other forces of "energy glut, peace scare, and budget restraints" questions again the directions of the laboratories. Yet, these laboratories must address not only the national security needs of nuclear weapons development and design, the national security needs of energy independence, but also the important national need to enhance our economic competitiveness.

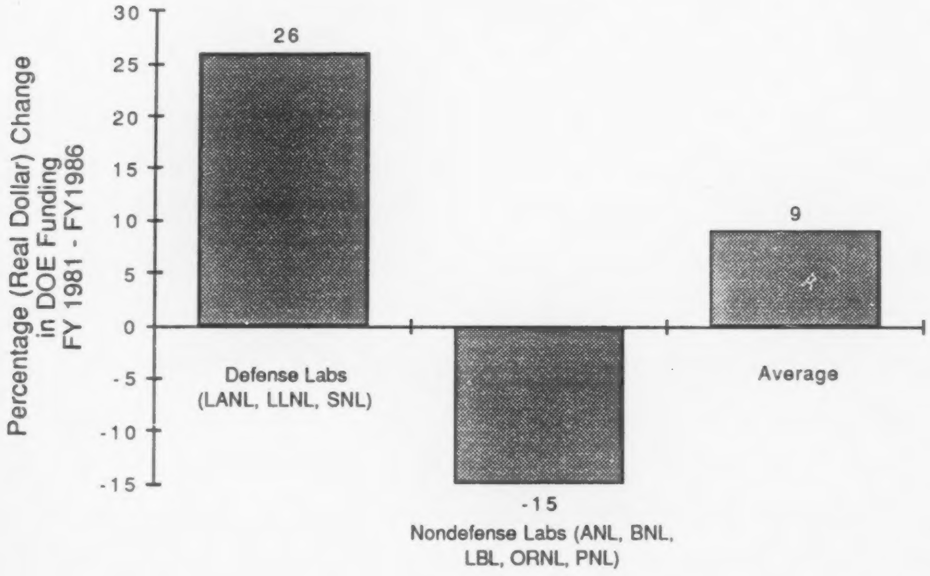
The DOE laboratories underwent an important change beginning in the mid-1970s during the energy crisis. Many grew rapidly (even too rapidly) and chose specific areas in which to help solve the energy problems through technological means. Due partly to conservation, to the worldwide economic slowdown, and to changes in government policies, the energy crisis evolved into an energy glut, and the technological energy missions of the laboratories changed from an expensive near-term focus to a more orderly and less expensive long-term, high-risk research orientation. At the same time, the country's consciousness about national defense increased, and the weapons laboratories grew rapidly while still retaining many of their energy missions. In fact, a look at some of the budget trends (shown in the graphs) would indicate that, indeed, the weapons laboratories have been very successful in retaining, even increasing, energy missions during a time of overall buildup in other areas. The flexibility given the DOE weapons labs, which permitted simultaneous growth in weapons and nonweapons R&D, is the envy of the entire national laboratory system.

Dealing With Change

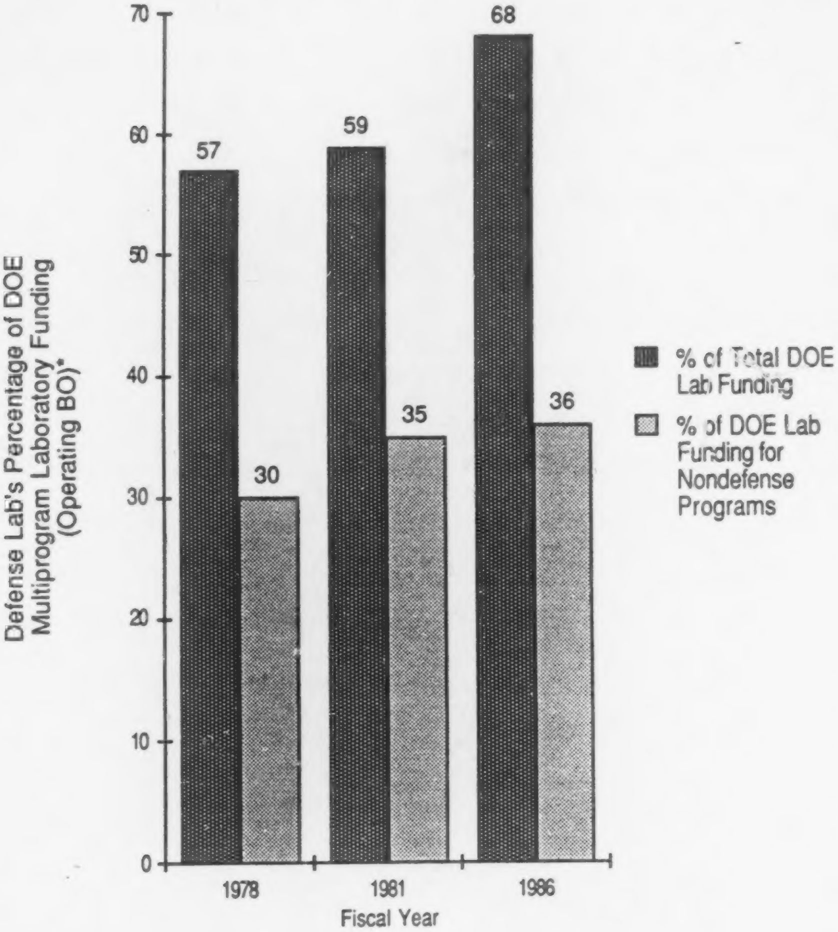
The need for certain categories of nuclear weapons appears to be decreasing, but the weapons laboratories will still have a unique role to play in defense. The valuable expertise assembled at the weapons laboratories can be applied in nonconventional ways to conventional weapons. The important questions of verification of nuclear weapons treaties and the vast research necessary for an effective Strategic Defense Initiative (SDI) program give the weapons laboratories ample justifications for retaining a large skilled work force.

In addition, it has been recognized that the government-owned and contractor-operated facilities are uniquely capable of moving rapidly to recruit the best and to bring immense resources to bear on national defense problems. At the same time, reviews of laboratories operated by the Army, Navy, and Air Force have revealed that much of the work at those laboratories is project management rather than R&D. I believe that an ideal marriage might take place by linking DOE laboratories more closely with the military laboratories. This union would greatly strengthen the nation's capabilities in advanced weaponry.

DOE HAS PROVIDED MORE FUNDING TO THE DEFENSE LABS (AND LESS TO THE NONDEFENSE LABS) OVER THE LAST FIVE YEARS



THE DEFENSE LABS HAVE INCREASED THEIR SHARE OF DOE'S NONDEFENSE FUNDING



*Excluding Ames and INEL

Because the DOE weapons laboratories have exhibited their ability to greatly expand their functions, as was done in the energy-crisis era of the mid-1970s and again during the time of national defense buildup in the early- to mid-1980s, there is little concern about the capability of these laboratories to compete favorably and fiercely in technological areas. However, a number of arbitrary boundaries have been established to constrain such competition. The next challenge for the national laboratories as a whole is to contribute, in a more structured way, to the global competitiveness of U.S. industry. The Domenici Bill focuses on areas of semiconductors, high-temperature superconductors, and research on human genome sequencing. All of DOE's national laboratories (not just weapons) have a strong role to play in assuring that the technological base for global competitiveness is firmly in place, and increasing the capabilities of these laboratories to transfer that technology to American industry is imperative.

Suggestions

A number of actions can take place that would more closely align all DOE laboratories with the national purposes of national security, energy, and economic competitiveness. They include the following:

1. **Eliminate DOE's current limit on work for agencies**. Now only 20 percent of a laboratory's work can come from non-DOE sources. While some rule is understandable (because DOE has responsibility for the laboratories and the laboratories must be responsive to DOE), the 20 percent figure is too constraining because of the size of the issues that need to be addressed (a limit of 40 percent is suggested). The 20 percent will be easily exceeded as DOE's budget declines and others remain constant.

2. **Continue to improve the technology transfer mandates**. Congress has taken important legislative steps to improve the ability to transfer technology to American industry. Time is of the essence in many technology areas because word of new developments has a way of spreading quickly; the ability to transfer patents to give Americans a competitive advantage is crucial. Several hearings have already been held on this issue, and while progress has been made in the last few years, more action is necessary to speed up the process.

3. **Discourage invasions on scientific budgets.** There has been a growing tendency for Congress to create pork-barrel projects to fund science facilities at specific universities. Through strong lobbying efforts by a growing number of universities, the DOE budgets have been raided to create buildings for universities. Although the need to improve our universities is certainly important, the way in which this is approached--not being subject to peer review, DOE mission, or demonstrated need--has created numerous budgetary problems. These budgetary problems will very likely extend well into the future; after the buildings are built, DOE will probably be required to fill them with research programs again from constrained budgets.

4. **Aggregate similar work to increase efficiency.** Our most valuable resource, that of the intelligence, creativity, and motivation of our chief scientific brains, is still encumbered by the ever increasing minuscule requirements that come through finer subdivisions of budgets into smaller and smaller packages. The freedom to carry out work within appropriate constraints is important, yet finer subdivisions have imposed constraints that are unnecessary and that reduce our efficiency.

5. **Resist the urge to create new laboratories.** Large new national laboratories have been created: for example, SERI and CEBAF do not take advantage of existing expertise and therefore introduce further inefficiencies; Sandia and Argonne were excellent places to carry out that work.

6. **Retain exploratory flexibility.** The weapons labs have had an unaccustomed degree of freedom in exploring new areas because of the nature of weapons funding. As they turn to other endeavors that flexibility should be retained (and extended further to other DOE labs).

7. **Expand national defense role of weapons labs.** The nation's defense R&D would be vastly improved by expanding the defense role of DOE's weapons laboratories. This role might include technologies associated with verifying weapons treaties, development of strategic defense systems, and closer associations with the DoD laboratories.

Summary

In the past, DOE's national laboratories have played an extraordinary role in the development of the national security and technological competitiveness of this country. They have the proven ability to accommodate rapidly to change, to take on new missions, and to find innovative and crucial solutions. Yet, constraints imposed on these laboratories have caused them to be operated with less than optimum efficiency. I believe that the removal of the 20 percent limit imposed by DOE, improvement of the technology transfer options, and allowing flexibility in the use of funds within the laboratories will enable these national laboratories to more fully use their vast scientific and technological resources to help the nation meet the global competitive challenge and to be national laboratories in the complete sense of the word.

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Senator BINGAMAN. Thank you very much.

Sig, we heard testimony from the other two witnesses on the Gramm-Rudman issue. Before we start our questions, if you have comments on that, we are glad to hear them.

Dr. HECKER. I would like to make just a few points.

I share the concern of my colleagues that if the cuts are as deep as they have been indicated in the newspapers the past few days, that indeed we face definite reductions in force.

The concerns that I have are that, as I have mentioned before, in the nuclear weapons program we have already been on a downward slope for the past couple of years, including this year, being hit hard to the tune of having to take off 300 FTEs from our nuclear weapons program with the hope of finding someplace else within the laboratory.

That was before the Gramm-Rudman impact. So as we look over the past couple of years, our nuclear weapons technology programs have lost 500 people. And so the additional Gramm-Rudman effects on top of that 500 people, I think could seriously erode that nuclear confidence that I talked about.

The additional aspect is that it seems ironic that at a time when this Nation needs to have its best foot forward in technology that we are going to indiscriminately cut the budget and hurt the very future of our country, and that is the research and technology base.

I guess the last comment on Gramm-Rudman, from our standpoint, that certainly the longer the situation is dragged out in terms of coming to a resolution, the more difficult it becomes for the laboratory to deal with that, because of the fact that we have to deal with the reduction being over an entire year, whereas we will already be significantly into the fiscal year before we can make any gains. Thank you.

Senator BINGAMAN. Thank you very much.

Let me just say that because we are running late, as these hearings always do, we will try to limit ourselves each to about 5 or 6 minutes of questioning.

Let me first ask Sig a question. The third point that you made dealt with how diversification in areas other than nuclear weapons has brought with it drastic changes in the way you do business, and that many of those changes undermine the basic strengths that have contributed to the excellence of the laboratory.

You are talking there about the same kinds of problems that Dr. Davis and Mr. Welber are speaking of with regard to the fact that the more work you do with DOD, the more procedural requirements are imposed and the less flexibility you have on allocation of resources.

Is that basically the point you are making?

Dr. HECKER. That is correct. I guess it is a simple fact, the more customers that you do work for, the more paperwork that is going to be associated with it. That is one aspect.

The other one is the fact that the DOE has had the recognition and let us say a long-term ownership and godfather role for the laboratories, and that is certainly not shared by the other government agencies.

So, because of that, we do not have the same long-term orientation, coupled with the greater paperwork that just makes it much more difficult to use our talents in the optimum fashion.

Senator BINGAMAN. One of the issues that has been brought to my attention several times and that we have been trying to deal with, and we in fact have language in the defense bill again this year to try to deal with it, is this need to get timely approval from DOE of requests or applications that are made for patent licensing or transfer of patents to the private sector.

To what extent is that problem getting fixed?

In my efforts to push language on that this year in the Defense authorization bill, we were met with the response that now the problem has generally been fixed, and DOE turn-around is much better than it was a year ago and we do not need stronger laws in this area.

I would be interested in your reaction.

Dr. HECKER. From our perspective, I think the time scales have been spread up to some extent, but the problem is by no means solved.

I think the hope that I really have is that in dealing with the Secretary of Energy's office on the high-temperature superconductivity initiative, that with that program we can develop a pilot to take an entirely different approach to the whole patent licensing right issue, and it will probably take that in order to make the laboratories a sufficiently friendly place to do business with the private sector.

Mr. WELBER. As a result of the kind of delays we have had in the past, we tend to try to avoid the issue, and we are not asking for as many waivers, and consequently on a recent transfer of technology to a small company locally, we decided to go without a waiver and this company began to explore our technology, and before they were willing to really devote capital resources to perfecting it, they examined their vulnerability without having that protection and decided not to use it, regretfully.

So there is a case where technology transfer fell by the wayside because the company felt they did not have the protection of a patent.

Senator BINGAMAN. Dr. Davis, do you have a comment on that?

Dr. DAVIS. Yes, I do. It is our understanding that the Public Law 99-502 was interpreted not to apply to Government-owned, contractor operated, but only to Government-owned, Government operated facilities.

We would very much encourage an interpretation or some new legislation to change that so that it also applied to governmental and contractor operated facilities.

We also are very much in favor of an elective process, for instance, a waiver process in general, so that at a local level it can be determined that we can enter into working arrangements with industry; namely, the director of the laboratory or the university of California directly could make those arrangements through an elective process rather than a waiver process.

Senator BINGAMAN. Mr. Welber and Dr. Hecker, I get the impression from the testimony that perhaps in the case of Lawrence Livermore there is a greater tendency to actually bring industry in to work in the laboratory. Industry employees, engineers and scientists could work in the laboratory for extended periods to accomplish some of the interaction.

I do not know if that is an accurate impression or not, but Dr. Davis' testimony seemed to me to indicate that they do that to a greater extent than I had understood was happening at Sandia and Los Alamos.

Could you comment on whether that is accurate?

Mr. WELBER. I am not sure myself, Senator Bingaman, but to the extent that we do get involved with SEMATECH, if we do get involved with them in the near future, our involvement is going to be very deep and with a large number of semiconductor companies and it will be enduring and strong.

So I do not think we have ever seen anything like that up to now. It has been rather sparse in a few instances, but not that many, really.

Dr. HECKER. In our experience, we have had what we call the industrial staff member program for a number of years and I would say until the past couple of years those have run less than a handful of people typically at the laboratory in any given year.

However, in the past 18 months or so, we have scaled that up significantly because we recognize in programs like the free electron laser program, the particle beam program, that we do need to have this closer interaction with industry, and so we have actually had people from the private contractors come and work at the laboratory and it is probably on the order of 10 to 15 or so professional people at the laboratory right now.

As we go into 1988, we had planned to have the industrial sector pick up a substantial part of the activity of the ground test accelerator at Los Alamos, and so we are expecting that to increase to perhaps on the order of 40 or so industrial people.

Senator **Bingaman**. Did you have any comment, Dr. Davis, on the extent of Lawrence Livermore's use of this device?

Dr. **Davis**. It is expensive and we are continuing to try to move more and more in that direction. I could not give you a head count, but it is less than 1,000 and greater than 100. It is in that range. I just do not know the exact number.

Senator **Bingaman**. That is not bad for Government work. [Laughter.]

Senator Glenn.

Mr. **Welber**. Could I make one addition?

Senator **Bingaman**. Sure.

Mr. **Welber**. I did not mention our combustion research facility in California, we do have automotive interns from General Motors and Chrysler, Ford, Deere, and Toyota, and Datsun. The activity there is extremely valuable and that is what I was referring to in attempting to keep some of this kind of activity restricted.

Senator **Bingaman**. Senator Glenn.

Senator **Glenn**. Thank you, Mr. Chairman.

Just to follow along a little bit on that, I am not quite sure how the autonomy works here or could work. I know you would like to have—in an ideal world you would like to have a bag of money and you can go out and contract with the local people and help businesses and you would like to help them do research and coop research and work out all sorts of things like that.

How much autonomy do you have now and how much do you think you should have, because there has to be some sort of limits. We are not going to have big bags of money, at least not for a while yet, to do things like that and there has to be some coordination with other labs, and so on, so you are not duplicating.

How much autonomy should a lab director have? He either has to have some limitation on dollar value or some limitation that you are staying without a certain concept you have been given.

In other words, you cannot be out—you might love to have, to make a ridiculous example, growing peaches, you may have some great scientist on your staff that thinks he can grow peaches better than anybody else, so there is no point in Los Alamos trying to outdo the Beltsville, MD on how to grow peaches. It would be duplicative and we would not want to get over in that.

There has to be some limitation here on your autonomy as to either a dollar value that you can go up to a certain level or a concept idea or both.

Mr. **Welber**. Let me try to tackle that first. We do have very specific rules and regulations for work that we do for agencies other than the Department of Energy. From a policy standpoint, there are specific regulations as to what the laboratory would try to accomplish.

Right now there are no specific percentage regulations as such. If you mean the autonomy that the lab director has to utilize, let us say, discretionary moneys, that is a different question. That is one that has been handled by a number of review panels who have suggested that that number ought to be in the 5 to 10 percent ballpark.

Actually, Senator Glenn, all the reimbursable funds that we have come through the DOE, so that we do not go out and get independent sources of funds for our operation.

We try to monitor that very carefully to maintain the size of Sandia at such a level that we can respond as well as possible to fluctuations in budgetary changes, so that the DOE continues to be the agency which monitors all of our reimbursable funds.

Senator GLENN. In other words, you have to get their approval on everything?

Mr. WELBER. They provide the approval for all the reimbursable funds, absolutely.

Dr. DAVIS. I do not have a lot to add to that. I think that is it.

Senator GLENN. Let me ask something in a little different line here. I have been much involved with GAO for a number of years now with the status of the DOE production facilities, weapons production, the missile production facilities, starting from Fernald, OH, where I first got into it with some bag house leaks there a few years ago, and we went out beyond that and we now have a total of some 21 different GAO studies, some of which I commissioned, and some that other people did. There are now 21 reports since 1979 about the general status of our production facilities around the country.

The safety aspects and the aging of these facilities is not a pretty picture. The newest one of the facilities was built 24 years ago, and it is no secret we are operating Savannah River at 50 percent with one reactor completely shut down, the C reactor. The end reactor at Hanford is shut down and on stand-by status right now.

The three reactors remaining that are operating at Savannah River for treating plutonium are operating only at 50 percent capacity and that is a long story in itself as to how we arrived at that level.

Anyway, the point being we are going to have to do one tremendous clean-up job with these facilities, and we are probably going to have a rebuilding job on our hands, and we have not dealt with that yet.

There is going to be tens upon tens of billions of dollars involved with this, which nobody has budgeted yet or even come up with a figure yet. DOE has worked on it. They have guaranteed me they will have it late next spring.

So this cleaning up and decommissioning and recommissioning, and so on is a mighty, mighty big job, and nobody knows what it may cost.

What can your labs contribute to that? I guess probably I would ask Livermore and Los Alamos, primarily, but maybe all three of you on that.

Dr. Davis, do you have a role to perform there? One reason I ask this is we are talking about the nuclear business going downhill. You are going to be involved in some of this decommissioning and clean-up. Your business is going uphill, I think. So what role can you play there?

Dr. DAVIS. Well, I think we have technology at the laboratories that has been developed through, say, for example, in our case our specialized separation program. We develop chemical processing techniques that we think will be very valuable in cleaning up waste around the defense production sites.

In particular, we were concerned with recovery of plutonium in that waste. And so that is just one example of the type of technology that is available.

Now, it has not been developed along those lines. We have not been given a charter to do that, but we certainly, I think could contribute a lot.

That is just one example of the type of thing we could do.

Senator GLENN. Have you ever been asked to look into what your role might be in that clean-up program of the existing sites that you mentioned, as well as the development of the new technologies that might replace existing ones?

Dr. DAVIS. Only in a sense of, I think we had a person involved in a recent study of the sites as to what the site, the situation might look like 20 years from now of 30 years from now, but no real technological evaluation of what might be done has been carried out in any sort of way by our laboratory as far as I know.

Senator GLENN. Dr. Hecker.

Dr. HECKER. Actually, we are quite involved with the Department of Energy, as well as with the Department of Defense on precisely the kind of questions that you are asking.

As you well know, until today, the sort of clean-up scenarios have been very crude, mostly physically based of just either covering it up in some fashion or moving it out, and yet there have got to be more scientific techniques, and actually we have $400,000 worth of funding from Defense programs to look at more advanced techniques, both advanced consideration techniques as well as biologically inclined approaches instead of the crude physical techniques.

So we are doing that for the Department of Energy, and to some extent we are doing it for hazardous wastes and explosives for the Department of Defense.

In my opinion, the laboratories can indeed play a substantial role in doing the R&D to make that job not as monumental as you indicate it to be.

Senator GLENN. Well, far be it from Ohio to give New Mexico Senators advice on how to do their business, but I think that is going to be a mighty big job and you may want to stay on top of that because I think the labs here could play a vital role in that area.

It is not just the equipment itself that is going to have to be dealt with. It is what has happened on these sites. You mentioned the sites. I don't know how we deal with contaminated aquifer level.

We have wells with aquifer levels downstream from Fernald were we have the wells closed because of radioactive water.

How do you clean up an aquifer level? How do we keep it from spreading?

The solution to pollution is dilution, they used to say, pump more water in and spread this stuff out so it is diluted. I am not sure that with Cincinnati being downstream you want to dilute it into Cincinnati either.

So you have some mammoth problems that we have not yet learned how to deal with. These are big areas that I would think some of your expertise could be brought to bear, could help bring to bear some of the solution.

Dr. HECKER. Just to add to that, again, we do have work. I am looking at the transport of hazardous or toxic substances in geologic media, and actually do have a national environmental research park at Los Alamos to study those type of problems with the semiarid climate that we have here in the western States, not in Cincinnati, OH.

Nevertheless, those are the sort of capabilities that we are looking at.

Senator GLENN. Well, my time has expired, but let me say that some of the sites around that whole circuit of the nuclear weapons production program have been there a long time.

When they were put in—the newest plant, incidentally, is 24 years old. So that is a factor in itself. But a lot of the things we know how to monitor now we did not know how to monitor maybe 25 or 30 years ago.

So we are now coming up with new techniques, and it would seem to me you people are in the forefront of those new techniques development areas.

Mr. WELBER. An important part of doing that would be the disposal and storage of material, and of course, we have had some real experience at the Carlsbad site where we are doing a waste isolation pilot plant, WIPP, so that we have had some real experience in understanding what happens, to waste as it penetrates the earth's strata.

Senator BINGAMAN. Senator Domenici.

Senator DOMENICI. Mr. Chairman, let me first say, in response to your inquiry in your letter of invitation with reference to Gramm-Rudman-Hollings, I think we ought to all understand, and I want to say that I do, I do not see how anyone can really tell this committee or any committee the precise effect of Gramm-Rudman-Hollings.

Frankly, we have such a crazy scheme for implementing grit that we are not going to know its full impact until it is carried out. I can give you a rough estimate cut, it you all want to apply it to your budgets.

Off of current year's levels, Los Alamos would lose $50 million. Off of current year's levels, Sandia will lose $62 million.

I am sorry, Dr. Davis, I do not have yours, but I do not see any reason for it being too much off in ratio, so you apply it to their budgets and my guess is that you are somewhere in between the two.

I do not know that what we are thinking about by way of a settlement in Congress will work. Neither do I think it indicates where we will come out because we are talking about reviewing all of the domestic appropriated accounts, and strangely enough, the Department of Energy defense account comes within that because it is funded by the Energy and Water Development Subcommittee and whether it would be protected as it moves into that account has not been decided.

But if we are talking about something like a 6-month freeze and then 6 months at 2 percent, and then 6 months or a year thereafter at 2 percent, we are not talking about literally freezing accounts in that manner, but rather the cumulative accounts.

So there again we would be putting the problem back in the laps of the appropriators to decide what preferences they were going to give.

If we were to ask how well can you get along with a freeze, your answer might be wrong because what you get depends upon how the freeze is treated in the appropriate bills.

None of these three Senators want this sequester, not just because we think it is kind of a dumb way to run the Government.

We are going to have some absolutely ridiculous results, but that is enough of that.

Let me this about the patenting issue and then move over to one other area.

Frankly, in spite of all the patent laws that have been passed, Bayh-Dole, the executive order and the new language in the Defense Authorization bill patent references, we are still having with the national labs. See if you agree with me that the problems are twofold.

First, we are treating the GOCO and GOGO labs differently. If they are GOCO's, they are treated one way, and if they are GOGO's, they are treated another.

That means that Sandia Labs are treated differently from Los Alamos or Livermore because you are managed by a private corporation.

Even though Sandia Labs are nonprofit, they are called a Government-owned company.

Mr. WELBER. We hope AT&T is profit.

Senator DOMENICI. Yes, they are, but Sandia is nonprofit. The Government does not make any profit from you.

I just want to lay this issue on the table quickly, and ask you if you agree, and go on to the next point. Do you agree that at some point in time we ought to treat all the labs the same?

Mr. WELBER. Absolutely.

Senator DOMENICI. How about the rest of you, do you think we ought to treat them the same?

Dr. HECKER. Yes.

Dr. DAVIS. Yes.

Senator DOMENICI. Second, what has really happened is that in spite of the Bayh-Dole and the executive order, which provides a broad exception to the individual waiver, there is also a little clause in there that in national security matters you can exempt certain items and put them back into the individual waiver category.

I read your new contract and it does not change much. Unless the Department of Energy changes and stops taking that little clause that says you can exempt this or that process and put it into the individual waiver on national security grounds we are going to have problems, DOE locks at our labs and they exempt almost everything and put it into the individual waiver account.

Even the Department of Defense does not do that in the labs it runs, but DOE does, and so almost all of your activities are back into the individual waiver, account.

Now, Dr. Davis, is that what you were directing your attention to when you said we ought to find a way to alleviate that burdensome problem. Am I correct?

Dr. **Davis**. That is correct.

Senator **Domenici**. Now, do any of you see any absolute need in the interest of national security, and I will understand if you cannot answer based upon working for the Secretary of Energy, but do you see any reason why we have to exempt such huge portions of your activities like that?

Is there not another way to do its so that we have a minimal amount of individual waiver requirements as compared with the maximum that we now experience?

Mr. **Welber**. I think in your opening remark, Senator, you put your finger on it. It is going to require a change in culture, a change in view of mission. And when that happens, I think we will find more freedom. and until that time, if you want to live by the rules, you can live by the rules.

Senator **Domenici**. Can we not do it with a new rule and not violate our national security concerns? I guess that is my question. Do you think we are ingenious enough to find out what is and what is not deserving of waiver for national security instead of blanketing the whole thing?

Mr. **Welber**. I think so.

Senator **Domenici**. How about you?

Dr. **Hecker**. I think the one test case that we had was the whole area of classification, before we are done, the similar problem of the last 40 or so years, so I think that can be negotiated with the Department and should be able to be.

Senator **Domenici**. All right. Now, let me ask about your hands being tied on contracts with outside people.

This will be my last question. I understand the limitations imposed upon you. Let me try something on you and then each of you say if it makes sense.

Since the Senator from Ohio raised the very interesting point of a dollar limitation, what if we said that each individual case cannot be more than a $10 million contract, if you want to do it independently? What if we said that it cannot be more than 5 percent of your total laboratory business in any event? What if we said you can do it and we gave the Department of Energy 30, 60 or 90 days to comment yes or no after you approved it. We could make every contract conditional upon a 60-day waiting period for DOE to say no. Would that give you some kind of latitude that might be operative?

Dr. **Davis**. I think that would be a very good step.

Senator **Domenici**. Sig, what do you think?

Dr. **Hecker**. I think we clearly need to expedite the process and anything of that nature would have to have a limit. It is my own feeling, and has been all along, that for instance, a 5-percent limit of total work with industry under any of those circumstances is a maximum.

I think the other alternative that could be explored is to have the field offices of the Department play a much greater role in this process than they do now, so that everything does not have to go back to headquarters.

I think that could also speed up things immensely.

Senator **Domenici**. Mr. Chairman, I do not even want to ask this question, but for your consideration and yours, Senator Glenn, I want to suggest that there is also a great concern about royalties. People can get very worried about any of these institutions having royalty moneys coming in.

I have, in Part I of my bills, out of frustration I have put in an idea. I will just describe it here for the record. Since they are nonprofit, we do not want them to get rich. I put in a provision that the royalties go back into the institution for continued research only.

I do not know how anybody would be worried about that. In other words, the labs would use it exclusively for research efforts. I assume that 10 years from now Congress would set off the income from royalties against your budget if you really got flush. But in the meantime, I think that is somewhat of a way around their concern that you are going to get rich by working with the private sector.

Mr. **Welber**. I think you described a workable proposal, Senator Domenici, and I would like to see it worked out with the Department of Energy and the labs, for something that we can all live with, and I am sure we could.

Senator **Domenici**. Thank you, Mr. Chairman.

Senator **Bingaman**. Thank you very much.

I think, because of the constraints of time, we are going to have to ask the second panel to come forward. We appreciate the testimony of this panel very, very much.

Senator Glenn has one comment.

Senator **Glenn**. From a previous incarnation in which I was involved in NASA, they did a lot of spade work in working out some new ways on patents, who has what rights, and so on.

You might want to look at some of those examples. I do not know if they are absolutely what you would want to follow, but you might want to look at some of those things. That is a difficult area for you to deal with.

You also mentioned 2-year budgeting. We are experimenting with that in the Armed Services Committee for this year and the next year, and I am not too sure how it will work out considering Gramm-Rudman.

I do not think this is going to be a fair test of the 2-year cycle this year. We have to move to 2-year budgeting. I think that is something that there is a pressure building for. Pete is an expert in that area more than I am, but I think that is a building pressure.

Another thing, too, if you are talking about contracts, that might be a $5,000 entrepreneur down the road someplace who may benefit percentagewise a lot more from some of your expertise than the guy that can put in $10 million.

So do not forget to work the little guys into this thing, too, because they are the entrepreneurs who really make the new jobs in this country, and I do not want to see them left out.

I don't want to let Pete's last comment go by without also commenting on it. I don't object if you get rich. [Laughter.]

Senator **Domenici**. I don't either, but somebody else does. [Laughter.]

Senator BINGAMAN. Okay. Thank you all very much.

Why don't we take about a 4-minute recess here while the next panel comes forward.

[A short recess was taken.]

Senator BINGAMAN. Why don't we start up again here

Unfortunately, we are always pressed for time. Let me thank the members of this second panel for coming today. We will try to follow the same procedure here we did the first time, which is to hear from each of the panel members, and then ask questions ourselves.

Our first witness is Dr. Gerold Yonas, the president of Titan Technologies, which is a San Diego-based high technology firm.

Prior to joining Titan, Gerry served for 2 years as the chief scientist and acting deputy director of the Strategic Defense Initiative Organization.

For over 10 years at Sandia he worked on pulsed power.

We are very glad to have you back here in Albuquerque and we look forward to your comments.

STATEMENT OF DR. GEROLD YONAS, PRESIDENT, TITAN TECHNOLOGIES

Dr. YONAS. Thank you, Mr. Chairman, and Senator Glenn and Senator Domenici.

It is a pleasure to be back here in New Mexico. Fortunately I had an opportunity to have my dose of the local cuisine before the hearing. Every once in a while I suffer chile withdrawal symptoms and I have to come here to be put back into a proper frame of mind again.

This subject, the future of the laboratories, is one that I have thought about quite a bit, and I sympathize with my former colleagues in the laboratories when I hear about all the bureaucracy that they have to live with in dealing with DOE and I just want to remind the committee what a paradise the labs have compared to what it is like in the DOD in trying to go through the tortuous acquisition process that is resulting in enhancing the Nation's ability to produce paper instead of weapons.

So I think if they are unhappy, they really have no idea what it is like to live with the vast DOD procurement system. Frankly, I was in the private sector and working for the Department of Defense before I came to the national laboratories about 15 years ago. I had forgotten how well things used to work back then; being in the private sector now, working for the Department of Defense again and seeing how much things have changed, it has become clear to me that there really are problems in the DOD acquisition process. We will not discuss that here today, but it is certainly a major concern for national security.

In thinking about the future of the laboratories, I considered when is it that the laboratories really are able to excel, and my conclusion is, first of all, when they have a tough problem to solve, and that problem is one that is broad in scope. Second, is when they have a capability to deal with that problem. That means that they have the people, the facilities, and the tools such as computers and the large scientific codes; so just having a problem is not enough, they have to be able to effectively deal with it.

Finally, they need a clear role, and by that I mean they do not do well when they are in competition with other established institutions. As this pie of national defense shrinks, and the competition for the ever smaller slivers of pie increases, escalating competition will be created. It is going to be increasingly difficult for everyone who wants to really provide what is needed in national security to participate because what we need is collaboration at this point and not more competition. We need to learn how to share capabilities and knowledge in order to compete with our real adversaries. What we really need to solve the very difficult problems we face are first of all to figure out just what exactly are those problems. More and more today we have answers and we just do not know or agree on what the questions are. Once we have a consensus on the questions, we can organize and cooperate to find the answers in the most effective manner. Once we know what those key problems are, we can give our technical people the freedom to share knowledge and the motivation to use their innovation, then I think technology will provide the leverage that this country needs to solve those major problems.

Many of those problems have already been mentioned here today and laboratories clearly have the established requirement and the national role to solve those problems.

I am going to talk about eight specific problems today, but the three areas that are clearly on the plate of the laboratories today are nuclear weapons, energy, and the environment related to energy production.

The historical mission of the laboratories is nuclear weapons and that mission is not going to go away. It is going to be of continuing importance even if deployed nuclear weapons are reduced in their numbers or in the kinds of weapons that we rely on. We are likely to face limitations in testing as well as numbers of deployed weapons. In this environment, it is going to be even more important to maintain our technology edge and apply innovation to the maintenance of deterrence at much lower levels of threatened response to a possible conflict. It is unrealistic to consider nuclear weapons going away ever, and the laboratories have a vital requirement to maintain the technology edge as well as maintain the safety and security of a diminished stockpile.

The energy problem itself never really went away. It is going to gradually get worse, and could get a lot worse in just one day with closing of the Persian Gulf. The laboratories' ability to do the long-term energy research cannot be matched in industry and that emphasis has to be maintained and even strengthened. We backed away from that commitment and the labs must be given the opportunity to prepare for the energy requirements of the future.

The third problem arises from the connection of the energy supplies with the natural environment. We must be able to use fossil fuels in a clean way and understand the environmental impact in order to limit the harm to our environment. These are the kinds of large-scale problems for which the laboratories are very well suited. In fact, the energy and environmental problems are global in scope, and the laboratories working with the labs of other nations, can make a major technology effort to solve these problems we all face.

Now, there are five other problems I want to mention, and I do not think you would be surprised if I mentioned the SDI as an issue that we need to think about. I think the public has lost sight of the fact that the goal of SDI is to provide us with a technology base to enhance deterrence. The goal is to reduce the numbers and the kinds of offensive nuclear weapons and to replace that offensive deterrent, that deterrent based on retaliation, with a different mix of protection and retaliation, not just retaliation as we have today.

The labs have a vital role to play in that continuing effort to move away from our deterrence based strictly on threat of retaliation and to introduce defensive capabilities. The issue of nuclear weapons and their role in this new environment of smaller numbers of offensive nuclear forces, might require different kinds of offensive weapons and we may have to have nuclear warheads on our defensive interceptors. This issue of enhancing deterrence through the use of new nuclear technologies is an important part of the SDI. But there is another problem that is going to be increasingly important in the future, and that is "Star Wars."

By using the term Star Wars I call attention to the issues of space access and space denial and to draw a distinction from SDI that deals with a related but still distinct problem of creating a safer and more stable deterrence. As we look to the future of conventional weapons based on precision surveillance and precision guided munitions we envision the importance of the gunsight in space or the equivalent of the forward spotter for artillery. The ability to use space for surveillance, for finding targets and for communications, will become increasingly important to our conventional forces.

This issue of being able to utilize space or not be dominated in space will be increasingly important to national security, and the laboratories are already playing an important role. For instance, there are two laboratory/industry teams preparing the technology for a powerful free electron laser that could operate on the ground to deter the Soviet use of its advanced ground based laser capabilities. Other laboratory work in weapon effects, optics, space power, and particle accelerators could be vital to our future ability to utilize space as demanded by our security interests.

The sixth problem has to do with conventional weapons. Here is an area where the Soviets have realized quite some time ago that the combination of surveillance and precision guided munitions could give one the ability to intercept deep behind the forward edge of the battle against weapons and massed forces, and provide a very high leverage in preventing a surprise.

The keys are the eyes and brains of the forces, the surveillance and the computerized information handling power; here we have tremendous leverage compared to the Soviet Union, because we have a free society based on the free flow of information that has totally embraced the use of computers. The information revolution is affecting all of our lives every day and although we frequently talk about spin-off from weapons programs to the civilian sector, here we see spin-in. It is that spin-in that is allowing us to strengthen our conventional forces.

I think the Soviets fear or envy our ability to apply spin-in to the conventional force balance and I think this is one of the factors driving Glasnost. It is also one of the factors driving their desire to stop our SDI, which to a large degree, is based on advanced sensors, surveillance, and information processing. If the labs are to play a role here, they must work with industry and help the spin-in process.

The next problem is industrial competitiveness. Clearly, this is of everybody's concern today, and the laboratories have had a very difficult time really having any impact in this arena. The standard solution is spin-off to industry, and although they have tried to make technology transfer work, it is still in a very embryonic state.

From my view, the way to transfer technology is to transfer people. The way ideas go from one environment, from one culture to the next, is with people actually going out and working together. I think that the figure of merit in technology transfer is not the number of agreements or contracts, but the number of university, laboratory, and industry people that share offices. When we see not hundreds of university and industry people in the laboratories but maybe thousands, when we see lab people on sabatical, going out into industry, or even going out on a temporary basis into government or universities, then we will see new perspectives, ideas, and solutions. Once we begin to blend the perspectives of the marketplace, the operational warrior, the politician, the scientist, the bureaucrat, the technologist as well as even the philosopher, then we can begin to achieve the kind of technology transfer that is really needed.

Finally, let me mention one problem that I think we all face that requires greater attention. This is the issue of using information technology to manage, or even better, avoid disasters. More and more we are going to be faced with disasters resulting from a lack of adequate control of advancing, modern, complex systems.

Examples would be the financial community today. A nuclear reactor, an air traffic control system, a strategic warning system providing our strategic nuclear deterrent. The reason why this subject of manmade disasters—(or even natural disasters rather than self-inflicted disasters) is becoming more important is because our systems are becoming increasingly complex, they have interconnections that are very difficult to understand and they respond extremely rapidly in unpredictable ways to stimulus. The labs capabilities in large scale computer simulator and control should be of great value.

An additional factor will require collaboration with others, and that is the coupling of humans and their real limitations together with the tremendous flow of rapidly changing information. Only through optimizing the role of the human decision maker can we provide systems that are stable and do not run out of control.

We must clearly define the problems we face and evaluate the capabilities of our universities, industries, and labs to solve these problems. Then the key to solutions will be teamwork, bringing our technical people together constructively so that our society can prevail in the face of these serious issues. Given the necessary leadership and given the will to work together, I think these problems can be attacked and solved and the national labs have an important role to play in the areas I discussed today.

Thank you.

Senator BINGAMAN. Thank you very much.

Our second witness is Dr. James Cramer, chairman of Science and Engineering Associates, a professional and technical services firm based here in Albuquerque, which he founded in 1980.

Previously, Jim has been the vice president of Science Applications International Corporation, and a staff member at Los Alamos.

He is currently a member of the State of New Mexico's Science and Technology Commission. His specialty is nuclear physics.

Jim, thank you for being here.

STATEMENT OF DR. JAMES CRAMER, CHAIRMAN, SCIENCE AND ENGINEERING ASSOCIATES

Dr. CRAMER. Thank you, Mr. Chairman, Senator Glenn and Senator Domenici. I appreciate the opportunity to testify before this oversight hearing.

In my testimony I will attempt to provide a perspective of the commercial, private R&D sector that is important both to the economy of New Mexico and an important part of our national science and technology assets.

I will confine my presentation to technology transfer between the labs and private industry and the interfaces that I see are necessary for the purpose.

To give you a little background, our business, as is the typical business mix of most companies in our industry, derives its income mostly from the Federal Government through R&D contracts and contracts with other prime contractors to the Federal Government.

For the past 7 years, or since we have been in business, we at Science and Engineering Associates have been performing research and development under contract to all three of the DOE weapons laboratories that are represented here today.

I think in order to address this issue of technology transfer, I would like to take a little different cut at the technology in question and the mechanisms for transferring, and look at it from the market viewpoint. I think there are a lot of misconceptions that are created because we do not look at it from that perspective. I will just use two categories to illustrate my point today.

There is that R&D product within the laboratories that has been developed and cultivated over the years that is very specific to the mission of the laboratories and other government agencies. That R&D has a very specific market objective, and that is satisfying the defense oriented objective of the DOE programs.

The other element of R&D product that I would like to identify is that technology within the laboratories, that would be suitable for commercialization. It is this element that I see is important in dealing with issues of national competitiveness.

So I want to maintain this distinction, because there is confusion created because we lump these two categories together when we discuss technology transfer.

In the former situation—that is, those very goal oriented R&D projects where the labs are doing research regarding their primary mission—I have seen a great deal of progress in the last 10 years on those laboratories' part in working with private industry. And I think some of the examples that were cited here in previous testimony are illustrations of that.

The labs have learned how to issue R&D contracts to private companies like ourselves, and like the Martin Mariettas of the world. Most of that research has been done with very specific objectives. Those apply to missions on the laboratories and/or other agencies of the Department of Defense and Department of Energy. In this case the research and development product is mature enough to be applied directly across agency lines.

On the other hand, in the latter case, where we are looking at technology transfer that might be suitable for commercial application, I believe the laboratories' activities need to be improved and I would like to address some of the things that I think are necessary.

I think because the markets are different, there is, for example, a requirement within any arrangement that is made with industry to protect investments of real monies that are made by outside private industry to develop a technology to the point where it is marketable.

Oftentimes the technologies that have been developed in the laboratories, and they are some of the finest results of R&D you will find, are not refined to the point where they could be directly applied to commercial markets, and someone needs to put additional effort to mature them to that point. That effort usually has to be paid for with moneys that need to be protected with patent rights and data rights.

I think in order to achieve this end, the laboratories need to establish interfaces with industry that are business-like. And, let me just comment a bit on what I define as to what I mean as business-like. They need to provide knowledgeable individuals within their organization that have the capacity to make deals, and I know that is not a particularly attractive word, but that is really what is necessary.

These people have to be knowledgeable about what is required to the deal from the business perspective. The need to have the authority to negotiate patent rights and data rights in a timely fashion. I think we have touched on this earlier in the hearing. There are too many delays in the system to make those business arrangements work.

The other important thing that has to be provided in the interface is what I call a "look-in" capability. That is, private industry needs to be able to view what is going on inside the lab and at least participate in making the choice of those technologies in the lab that are suitable for commercialization.

I will just contrast that a bit. Some tech-transfer activities within the labs have been to go out and do a survey of what industry wants, and that does not work. It cannot be done that way. I think industry has to have a chance to look inside the lab, look at the technologies and make some of those decisions for themselves. The capacity to that has to be provided.

Finally, any tech-transfer program for the laboratories to work within must have realistic objectives and expectations.

Let me just comment on this issue of expectations. The Small Business Innovative Research Program—for which we have a knowledge base of 5 years of history that could be drawn upon, has some direct application to the issue we are talking about here.

This program has been very successful in cultivating innovative research products from the small business community, companies like our own; giving small business a chance to participate in a creative way for Federal Government contracts that only large businesses could have done 5 years ago. This has been achieved through Phase I and Phase II of the program.

However, a third phase of the program, the so-called commercialization phase, has been, I think, a failure. Although a small number of products have been continued in Phase III programs under Government sponsorship, little venture capital has been invested, which was originally intended.

There has been almost $1 billion spent by the end of this fiscal year in this program, and very little Phase III product has come out in terms of commercialization.

I am not criticizing the program. I am merely stating that this is an experimental fact. This is a program that was mandated by Government organizations. The subject of the research was mandated by the specific organizations to satisfy, thus at the front end there was not the objective to build commercial technology. So what I am saying, is that this may be a measure of how effective the labs' R&D may be for commercialization. It has evolved around very mission oriented, very specific applications, and because of that, there is not all that much there that would be suitable for commercialization, as I feel is true of the SBIR program. So I just want to say that I think the objectives of the program and the expectations of any program that would be planned must be realistic.

Let me just make a further suggestion that I think would work. There is already activity in place at the Los Alamos National Laboratory to create partnerships between industry and the laboratory on a very specific basis, that is, partnerships between individual companies and the laboratory for specific technologies or specific applications of technology.

I think that is moving in the right direction. I say we still have a problem with patent rights and data rights, but this interaction between the labs and industry through a partnership can provide for personnel exchange which gets back to what Dr. Yonas just said. I could not say it any better than he did. That this "look-in" capability that industry needs in the laboratory can be accomplished through the exchange of personnel. That can be fostered through such a partnership. But I still think we need to improve on the protection of patent rights and data rights to protect the investment that private industry will be expected to make in these partnerships.

Let me just conclude with a statement. I don't mean to sound pessimistic about the value of technology within the labs, but I think we need to approach this issue of commercializing Government-sponsored R&D more from the standpoint of mining diamonds than mining coal.

I think it is going to require very specialized, very detailed surgical approach in extracting technologies in the labs that have a value commercially.

Thank you.

Senator. **Bingaman**. Thank you very much.

Our third witness will be Dr. Laurence Lattman, the president of the New Mexico Institute of Mining and Technology. He has been the president there since 1983.

Larry came to New Mexico Tech after 25 years on the faculties of Pennsylvania State University, the University of Cincinnati and the University of Utah. His specialty is geology. He has made numerous contributions to this State already, including helping Herm Roser put together the State's bid on the superconducting supercollider project, which we are all well aware of.

Thank you for being here today.

STATEMENT OF DR. LAURENCE LATTMAN, PRESIDENT, NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY

Dr. **Lattman**. Mr. Chairman, Senator Glenn, and Senator Domenici, thank you.

I am going to tilt my remarks toward university, lab, industry interaction because that is my background and I am a representative of the universities here.

My two colleagues, Dr. Yonas and Dr. Cramer, have said several things that I had down, too, and I agree with them completely, as will come out in my talk.

In worrying about America's position in international trade competition, the quality of its defense systems and the quality of its manufactured products, the universities carry, in addition to a research role, albeit smaller than that of the national labs, the role of education.

Anyone who has tried to go out today, for example, and hire on the faculty an experienced material scientist finds it almost impossible to get them with the kind of salaries the university has available.

The concept which was advanced, I think, by Dr. Yonas of a routine or standard or accepted sabbatical leave policy for national lab personnel to spend time with universities is one very important way of overcoming this key shortage.

I do not mean visits for 2- or 3-day seminars or guest lectures. I mean the teaching of courses, being in essence on the faculty as a visiting professor for a 1-year period and interacting with students at the advanced undergraduate and graduate level.

Another very tasty thing that could happen in the university-national lab interaction is the introduction into academic departments of what I would call foreigners.

Academic departments at universities are notorious turf areas surrounded by barbed wire fences. If an electrical engineering department gets an academic position and hires an electrical engineer, and if a mathematics department gets an open position it hires a mathematician.

I am suggesting that the visitors from the national lab be mathematicians implanted in the department of physics, physicists implanted in the department of electrical engineering, and a forced cross-fertilization that the universities frankly have not yet succeeded in doing by themselves but I think could do if they could have people from the national labs who do not threaten the tenured positions of the resident faculty.

Government underwriting periods of residence back and forth exists already, for example, Associated Western Universities is a consortium which receives DOE money and sends faculty people for summer and other short periods to national labs, including graduate students.

We do not have the reverse flow, and the national labs are a marvelous repository of experienced scientific expertise untappable anyplace else in the United States or from any other source.

They also can deal and should deal with consortia of universities. One of the problems facing research in American universities today is the fact that only a few States have put together successful consortia of their major universities.

Such States as California or Colorado or Tennessee have put together consortia, but most other States have individual universities duplicating and triplicating each other, and I think this national lab acting as a center could be a seed around which consortia could be built.

The National Science Foundation has set up some centers recently for interaction of industry and universities. We happen to have one at New Mexico Tech in explosives, and it is an interesting combination.

We are a school, a university, Eglin Air Force Base is part of it, Picatinny Arsenal is part of it, China Lake Naval Research Station is part of it, and 11 private companies which manufacture what we euphemistically call energetic materials, i.e., explosives, are also part of this consortium.

It has been marvelously productive and the interaction has been very exciting, if not explosive.

Industry has different needs in the way of ideas in the national lab. This was brought out by the two colleagues who spoke before me. A company such as IBM could take an idea, just an idea it picked up at a meeting with the national labs, race home and get that thing commercialized in an extremely short period of time.

A smaller start-up company would need a much more complete technological development and help from the lab. It could not immediately, in many cases, commercialize an idea into profitable production with the rapidity of a major company.

Other problems that are faced is the fact that many American companies today, of course, are foreign owned, and increasing numbers are becoming foreign owned.

So if we have the idea that this should be somehow or other restricted to American companies, we are going to have a very severe problem in preventing that technology from going overseas.

Universities interacting with national labs and industry bring another flexibility to the dimension of what we call technology transfer. That is, they meet with consortia of companies such as this research center for energetic materials, so the national laboratories are not faced with the attack of favoring a particular company with Federal funds, but make it open to an entire industry.

One of the problems that I have heard brought up repeatedly is the fear on the part of some national lab people that they would be accused of favoring an individual company with research that had been primarily developed by public funds.

But if, in fact, through the university-national lab-industry consortia, such as NSF is triggering, any company that wishes to join for some nominal fee and take part in it is invited, then that accusation is not tenable.

In your letter to me, Senator Bingaman, you asked where I thought future work should be done in interaction between universities and national laboratories, clearly areas that private industry does not want to put a major research effort into, most of them have already been touched upon by panel 1 or my two colleagues.

Clearly, waste management is such a problem, and that includes the water pollution problem addressed by Senator Glenn earlier.

The problem of automation of quality control of manufacturing is a major problem which I believe the national labs and universities and companies working together can address.

Very frankly, if you just walk down the street and talk to the average American citizen today, you will get from him or her the concept that Japanese cars are better made than American cars.

I bought a Toyota and I have not been back to the guy who sold it to me yet, and I bought a Chrysler and I have been back three times in the first month.

Now, whether that stigma is deserved or not, it is mouthed, and if is mouthed enough times, of course, it becomes truth.

I believe that a major effort in automation in quality control that is very difficult for individual companies to carry on, because it is a broad based effort, only the monster companies can do it, is a major target that the national labs and universities can work on.

The whole field of materials, ALCOA, Aluminum Co. of America, announced about 8 months ago that it was going to devote $400 million to an all-out research effort in material science and engineering. They wished to become the Materials Co. of America rather than the Aluminum Co. of America, because aluminum is one single material.

I believe the future of material science and engineering, as a base for American industry, and all of high technology, including the defense research establishment, is pivotal and the materials expertise we already have, for example, at Sandia and Los Alamos, is probably unequaled in the world.

The interaction through universities and consortia with companies in the materials field is enormously promising.

The field of enhanced oil recovery, we get today anywhere from 15 to 25 percent of the oil out of the ground by primary recovery methods. Clearly, we must get a much higher percentage of that.

All of you are familiar with carbon dioxide during water flooding and fire flooding and polymer flooding and detergent flushing and all of the techniques, a bewildering variety, we have many, many problems.

The techniques are partially successful. A major research effort there combining the expertise, the broad expertise of the national labs, universities and consortia of oil companies is a clear possibility.

In our own case, we do have the Petroleum Recovery Research Center, which is funded by 16 major oil companies and the U.S. Department of Energy, but not the national labs.

Alternate energy sources has been mentioned.

I feel, then, in summary, Senators, that the two major areas that universities and national labs can enhance each other's effort are a sabbatical leave policy, formally stated and in effect in the national labs, for this marvelous impact of experienced people, particularly cross-fertilizing in academic departments, working with students both at the undergraduate and research graduate level, and these consortia which NSF has triggered, that just started, NSF's plan is to put a half million dollars in seed money in it for a few years and then go away and hope a great ear of corn will rise out of the ground.

The concept of consotria of companies, national labs and universities working together on common projects where each company can take what it wants from it, run home and do what it can with it, and I believe that in these areas the national labs can contribute significantly because in the long run they will be involved not only with the development of new technologies but the development of new technologists and students who are the future occupants of slots at the national labs.

Thank you.

Senator BINGAMAN. Thank you very much. We appreciate that.

Our final witness will be Ms. Joellyn Murphy, who is the vice president at the Public Service Co. of New Mexico, and has been since 1981, vice president for regulatory and business policy.

Prior to coming to New Mexico, Joellyn held positions of increasing responsibility in Washington in four different agencies, the Bureau of Land Management, the Environmental Protection Agency, the National Oceanic and Atmospheric Administration, and the Office of Management and Budget.

We are pleased to have you here.

STATEMENT OF JOELLYN MURPHY, VICE PRESIDENT, PUBLIC SERVICE CO. OF NEW MEXICO

Ms. MURPHY. Thank you, Senator Bingaman, and Senators Glenn and Domenici.

PNM's direct involvement in sponsored research at the labs is quite recent. In July of this year, just before Secretary Herrington's initiative, PNM reached agreement with Los Alamos and DOE to fund $570,000 for a 2-year program at Los Alamos to be called the "PNM Senior Scientist Fellowship in High Temperature Superconductivity. Shortly after receiving Secretary Herrington's assignment, Los Alamos in turn asked PNM to serve as an industry "proving ground" for testing out ideas and recommendations.

The PNM group working on this project with Los Alamos has contacted the nine multi-program national laboratories to gather information. We have made site visits to LANL, Sandia, Argonne and Ames and we have also been in touch with a number of US corporations with major R&D programs, including Westinghouse, General Motors, Bechtel, DuPont and U S West.

Later this month, PNM together with US West, under the aegis of the Santa Fe Center, will have a meeting of representatives from industry and the labs to review a proposed set of new ground rules and a "model program" to be called the Work for Industry Agreement, by which private companies could contract more easily with national labs for multi-year investments in high temperature superconductivity. (There is no obvious reason, however, why such a program could not be applied to other technologies.) We expect that the results of this meeting will be incorporated in Los Alamos' report to Secretary Herrington, which is due in early December.

It is as a participant in these efforts that I make these comments today. I would like to focus on four points.

1. These national laboratories are an enormous scientific resource that could play a much more active role in technology transfer and industrial research without eroding their effectiveness in pursuing their primary defense mission. If "peace were to break out," however, it would be both tragic as well as stupid to dismantle these labs' extraordinary combination of human talent and equipment rather than to redirect it to additional dual purpose technologies, non-defense or industry oriented research.

2. There are significant, but "fixable," impediments to the expansion of cooperative or industry sponsored R&D activities in the labs. The "fixes," involve less bureaucratic protectionism, more competition among the labs, and some cultural change within the labs' working environment.

3. The national labs are also significant regional economic resources, and under more progressive "technology transfer" ground rules—rules intended to encourage rather than discourage interaction with the private sector—they could be even more powerful engines of local economic growth. New Mexico's economy is vitally dependent on Sandia and Los Alamos' presence in the State, but at the margin, the State may be better served by 5 former Los Alamos employees starting new companies here than by 10 additional scientists joining Los Alamos staff.

4. The broader role for nuclear weapons labs does not necessarily translate into larger staffs or bigger budgets. Given both the Federal deficit crisis and the critical need to increase the private sector's capability for technological innovation, it is appropriate to ask how the national labs might accomplish broader objectives with fewer Federal resources and more innovative interaction with the private sector and with universities.

Before elaborating on these points, I would like to offer two general observations about technology and its transfer.

The first is that we often forget that technology is not just hardware. Technology can be a gismo or a black box, but technology is also new ways of doing old things, as well as ways of doing entirely new things. Program trading in stock indexes, for example, is as much a technology as is the computer upon which it depends. Overnight mail service is just as much a new technology as is a CAT scanner.

Thinking of technology as just hardware restricts our understanding of the complex issues involved in its transfer and its commercialization.

The second observation I would like to make is that technology transfer appears to be a body-contact sport. People make technology transfer happen. If we lose sight of the "people factor," the analysis of our policy options will be incomplete, and our policy choices will be much less effective than they otherwise could have been.

Technology is developed primarily by research scientists and engineers and by innovators who, by natural bent and training, are open and curious types, always searching for the new and for the future. On the other hand, the adoption of technology can sometimes be a harder task and certainly one that is often less glamorous because it is usually done in a very different environment—one that is characterized by resistance to change rather than search for the new. The diffusion of innovation depends on people adopting new technologies, and most people tend to prefer the familiarity of the way "we have always done it."

Yet development and adoption of new technology are two sides of the same coin.

In the future, U.S. economic growth and U.S. competitiveness in the global marketplace will be driven primarily by the relative rates of technology development and adoption by U.S. and foreign competitors. If U.S. industry can develop and adopt new technologies quicker than foreign firms can, U.S. production costs will fall more rapidly and U.S. investors, U.S. workers and U.S. consumers will be the gainers.

Competitiveness, then, can be thought of most simply as ultimately a "Technology Race." The prize goes to the country or to the industry or to the firm that can develop and/or adopt technology quicker than its competitors. It is a race in which the clock runs faster each year and in which the stakes climb higher each quarter. To win the race, the United States must find ways to move more rapidly from basic research to new commercial processes and new commercial products.

The keys to our competitive future, I believe, are to be found in: (1) the sustained investment by both the public and the private sectors in the generation of new knowledge; (2) the accelerated transformation of new knowledge into new technologies, and (3) the quicker and wider adoption of new technologies through commercial innovations.

I would like to turn now to my specific points about the role of the national labs and the potential for increased interaction with industry. My first point is that the mission of the nuclear weapons labs can be broadened without threat to their primary defense mission. The total annual budget of the nine multi-program national laboratories is about $5 billion. A rough survey of the nine shows that industry funded R&D in these labs currently amounts to less than $50 million a year.

This means that a tenfold increase in industry funded research at the labs—an order of magnitude increase—would still represent less than 10 percent of the national labs' total efforts at current funding levels.

It would seem that the Federal Government does not need to be overly concerned that an increase in industry funded research at the labs would divert them from their primary DOD and DOE tasks. On balance, the challenge is not how to prevent erosion of the labs' ability to perform their primary mission—rather, the challenge is to provide the appropriate ground rules and the proper incentives that will make the labs more attractive as potential partners to industry.

My second point about the labs is that there are real obstacles but that they are fixable.

The first obstacle is bureaucratic complexity and layering. The layers include on-site lab management, contractor management, DOE area operations offices, and various DOE offices in Washington.

I brought with me today nine separate contracts, warrants, licenses and royalty agreements—standing nearly 2 inches high—that had to be negotiated with one of the weapons labs, the lab contract manager, DOE area operations officer and the DOE at Washington before the lab could accept any money by a particular company to do sponsored research.

There has to be a simpler way. Our preference is direct contracting between the sponsor who is paying the bill and the lab that is doing the work. Our model program that we are working on with Los Alamos would be a 40-page document.

I should note here that there seem to be many differences in procedures as well as attitudes between the weapons labs and the other labs when it comes to interaction with the private sector. A small but symbolic illustration is that a contract with industry at Los Alamos is called a "Funds-In Agreement," and at Argonne it is called "Work for Others."

It also appears to us that DOE maintains a much more protective posture vis-a-vis the weapons labs in ways that seem unrelated to security needs.

A second impediment centers around intellectual property rights. There appears to be a notable contrast between congressional policy and agency practice here.

The U.S. Code, 18 USC 200, says that it is the policy and objective of the Congress to use the patent system to promote the utilization of inventions arising from federally sponsored research or development, to promote the commercialization and public availability of inventions, and to protect the public against non-use or unreasonable use of inventions.

One the other hand, one learns in the September 1987 issue of Business World from a reporter that has interviewed a variety of people that DOE is particularly, "hostile to industry-directed research. It has refused to give the labs authority to license patents to companies . . ." "The department's policy of reviewing every application for a patent or license case-by-case . . . is too much trouble and takes too long."

The reporter also quotes DOE officials as saying, "I would err on the side of reviewing practically everything, even if it involves delays."

At first blush, there does seem to be a world of difference between the spirit and the flesh here. DOE's regulations regarding the 18 USC 200 run to 52 pages of 6 and 8 point type.

There is another area of difference between the weapons labs and the others. For example, DOE has kept all intellectual property rights at Los Alamos unless the University of California specifically asked for them. Argonne, on the other hand, received all intellectual property rights unless DOE specifically withheld them.

I was cautioned by a lab patent attorney that it is heresy to ask the following question, but ask it I will. If under Federal law the Government always retains the right to patents for Government use in the public interest, why does it take 9 months to negotiate these same residual patent rights with DOE?

Another heretic's question that might be appropriate to ask is this. If just half of the DOE's patent attorneys in Washington were held accountable for making technology transfer happen rather than for reviewing it to death, by how much would we be able to increase the pace at which technology is being brought out from the labs and put to commercial use?

A second obstacle is the under-developed competitive spirit. A bit more competition in and among the labs, we believe, could be healthy. I would like to recount a story about competition in the labs.

At a recent meeting with Los Alamos staff about PNM's High-Temperature Superconductivity fellowship, PNM was stressing how important it is for the lab to meet industry deadlines when only a very limited window of market opportunity exists for the initial introduction of the new technology. The LANL folks stressed their long experience with meeting deadlines under budget on weapons work. And then we had this exchange:

> PNM: Yes . . . but for your weapons work, you only face one competitor.
> LANL: (After a long pause.) Who is that?
> PNM: "The Russians, of course."
> LANL: Oh . . . we thought you meant Livermore. [Laughter.]

There is an important truth behind this story. There is a competitive spirit among the labs, and perhaps it can be built upon.

Overemphasis on Washington based national coordination of High-Temperature superconductivity R&D, or any other priority research area can stifle initiative and ultimately produce fewer results.

All labs do not have the same capabilities, of course, but many have comparable abilities and interests. We believe that more play should be given to their inter-lab rivalries so that they can establish more distinctive competitive advantages in the minds of the private sector. Most companies who are interested in more interaction with the labs have significant competitors of their own. These companies will be interested in investing meaningful sums only when successful R&D can offer them a competitive edge in their marketplace.

A third obstacle to enhanced interaction with industry has to do with attitudes, incentives and motivators, within the labs' culture. I am taken aback, for example, when I hear lab administrators and scientists commonly refer to the private sector as "out there in the real world," or when a researcher describes a colleague as being "above" the profit motive. Such attitudes may impede the development of partnerships that must necessarily be based on mutual respect and trust.

In designing ways to stimulate more interaction and to make it more productive, we cannot forget the importance of the people factor. The labs could make better use of both monetary and nonmonetary incentives for individuals work groups and institutions as a whole. They could also make more use of flexible personnel policies that allow researchers to move out of the labs with the technology and then back again if, and when appropriate.

My third point is that the national labs could be more powerful engines for regional economic growth. Both Dr. Lattman and I recently attended a 3-day Town Hall meeting that involved 120 citizens from across the State. Sponsored by New Mexico First, the Town Hall's topic was New Mexico's economic development.

It drew two conclusions that are of interest to this hearing. The first is that New Mexico must assume responsibility for its own destiny. Excessive dependence upon Federal Government expenditures leaves the state vulnerable to each Federal budget.

"To allow New Mexico's economic development to follow a course determined by external forces is reckless."

The second conclusion of interest is that the R&D resources and capabilities in New Mexico, especially the national labs, are one of the State's most competitive advantages, one that could be a centerpiece in an economic development—strategy, not however as a source for more Federal dollars for the State, but as a source of more active technology transfer programs and commercial spin-offs that will result in business start-ups and business growth.

My last point is that a broader mission for the labs and more interaction with the private sector will not necessarily require larger staffs or bigger budgets. The challenge for the labs—just as it is for U.S. industry in today's more competitive environment—is how to do more with less. Both labs and industry must find more innovative ways to leverage resources and to pool capabilities.

PNM's grant to Los Alamos for the High Temperature Superconductivity fellowship is our first experiment in leveraging R&D resources with the national labs. We hope it will become part of a more productive interaction between the national labs and U.S. industry.

In sum, PNM is convinced that to increase productive interaction between the national labs and industry, the DOE and the labs must adopt policies and procedures that will do five things.

1. Create close and clear communication in control linkages between the labs' applied research team and the corporate client's research management team. A "work for industry" agreement should establish a direct contractual relationship between the laboratory and the sponsor.

2. Recognize that privately sponsored applied research efforts must fulfill the objectives of the sponsoring individual companies or the industrial consortia. The contract must hold lab investigators responsible for certain specific items of performance (not necessarily results) and may even provide incentive payments contingent on exemplary performance.

3. Accept fully the fact that privately sponsored research results will be proprietary and should be commercialized by the sponsoring corporate client, because this is the most efficient way for the Nation to benefit as a whole. The contract should grant the sponsor unambiguous control of all intellectual property arising out of the project.

4. Implement business-like practices for the planning, marketing, negotiating and executing of sponsored research for private companies. That is, cut the redtape at all levels and increase the labs' flexibility and autonomy. Such practices will increase the labs' efficiency and will greatly reduce industry's reluctance to work with the labs.

5. Use each laboratory's unique capacities to define a unique "market niche" for the conduct of privately sponsored research, and experiment with marketing programs such as ARCH in Argonne and EDGE technologies in Ames to establish in the minds of potential partners in the private sector that the value of R&D with the labs exceeds the price charged, exceeds the traditional cost.

Thank you. I would be happy to answer any questions.

Senator BINGAMAN. Thank you very much.

Let me just start by saying we have run overtime. I do want to go ahead, if time permits here with my two colleagues, and each of us do about a 5-minute question and answer session with you before we end the hearing.

I do think the testimony has been excellent from both the first panel and the second panel.

Let me just ask Dr. Yonas a couple of questions.

The eighth area you mentioned for inquiry, disaster management, I felt was fascinating. Using information technology to manage disasters is a kind of overarching problem you felt that the laboratories might bring a unique capability to.

Are you talking about managing disasters or preventing disasters, or is your thought that you could only get funding for the management of them? Congress would never be foresighted enough to fund the prevention.

Dr. YONAS. Senator Bingaman, I took this thought from the SDI activity called battle management, and I converted that to the topic of peace management, which meant that the purpose of that center, the national test bed, would be to learn to manage peace so as to avert war.

In that same vein, I should have used—instead of just saying disaster management, but the process of avoiding disaster.

The problem that I am talking about arises in many diverse areas such as, for instance, central care patient monitoring. Certainly this should not be called disaster management. Managing a hospital floor of critical care patients, where you have sensors and data management looking at blood circulation, respiratory rate, temperature, and the control of medication is very labor intensive and lack of control can lead to disaster. The key is to have an automatic system to collect and process data, so that hospital workers that are vitally necessary can step in and avert a disaster, can respond in a timely manner, but still in a less labor intensive manner.

I already mentioned air traffic control, which is a disaster waiting to happen, very large power plants, energy grids, our strategic forces, if we begin to increasingly introduce, as I believe we will, our military into space, the real issue will be to use these military capabilities for peace management, or averting disaster.

Here, the application of the computer, the application of parallel processing and methods for rapidly and reliably handling very large amounts of data, and then understanding what role the human should play and how effectively the human can react under stress, is an overarching problem for a lab role because of their very large emphasis thus far in large-scale computer simulation and information handling, obviously our Nation's information industries must also play a vital role. An example of a marriage between industry and laboratories is quite obvious here in Albuquerque, where we have AT&T managing Sandia, where you would think if anybody could begin to marry those two aspects of information handling and advancing technology it would be that laboratory.

Senator BINGAMAN. Dr. Lattman, you suggested about sabbaticals by lab personnel in universities. Then the other side of the coin would be to bring more industry and university people into the laboratories to spend time. My question is: is it reasonable and realistic to think we can pursue a limiting of the benefits of laboratory technology to U.S. industry with this kind of interaction going on?

If we are going to have the labs going into the universities and we are going to have industry and universities coming into the lab, is there any realistic way that we are going to manage this in such a way that U.S. industry gets a benefit that is denied foreign industry?

Dr. LATTMAN. Senator Bingaman, I do not believe you can deny it to the foreign companies. I think you can give the U.S. companies an advance, a lead. There is no way we are going to be able to keep the technology here, both from the point of view that many U.S. companies are in fact, or a significant part of their stock is held by foreign investors, some cases they are foreign owned.

There is, of course, the business of industrial espionage and the like. I think what we must attempt to do is give our companies, American companies an advantage, not only as they learn about it, but further interaction with the lab, ease of interaction.

I do not believe it can be denied foreign competition. I just do not see how it can be done.

Senator BINGAMAN. Let me ask one other question here before my time is up.

Your suggestion about automation and quality control of manufacturing, to your knowledge, is that something which the labs are at this point really capable of pursuing and helping industry with?

Dr. LATTMAN. To my knowledge, at least one of the national labs here has a fair amount of expertise in that field, quite considerable expertise, more in fact than any company I have dealt with.

In the business of automation and quality control, of course, many companies are involved, the big companies, General Motors, and the like, but there is expertise in the national labs. Much of it is the same type of expertise that Dr. Yonas was referring to.

I think that American industry has to recover its reputation for top quality, a reputation which, bluntly, Senator, has slipped in the last few years, vis-a-vis foreign products, particularly in the automotive field, but in other fields.

I think the national labs can contribute significantly there, and I know Sandia has expertise in that area.

Senator BINGAMAN. Thank you very much.

Senator Glenn.

Senator **Glenn**. Thank you, Mr. Chairman.

I do not want to be the skunk at the garden party here, because I do want to see information getting transferred where we can.

The mission of the labs has been for a very specific purpose. During the testimony here this afternoon, you almost outdid each other on what we are going to do to move this in, including where the labs working for the private sector, almost, instead of letting the information that is developed in a basic way flow out when it becomes useful.

Ms. Murphy, communications and applied research must address the needs of the customer, private research will be proprietary, all rights to the private whoever it is, cut the redtape and use each lab's expertise to work with specific problems for a particular industry is a summary of the way I wrote it down.

Now, others of you had that same idea here, and my idea of the national labs, I guess, is that they are to stick with their basic mission of very, very fundamental, basic break-through type research.

Along the way, a lot of that will become available, or should become available as these break-throughs occur.

U.S. scientists all are very much aware that you discover some new fact that is not usable at all, then you discover years later some new fact, and then you discover something else. Some day this all comes together and it gels and you make a quantum leap in whatever it is, in medicine or, you know, Flemming is curious about mold on garbage and everybody giggles at him, I am sure.

He is off doing experiments on plain old mold, but out of that and 20 other developments along the way, then comes penicillin and our whole antibiotics field, and so on.

What I am saying is, let us not carry this to the point where we are beginning to say it will not be basic research, it will not be the discovery of basic new scientific principles.

What I think the national labs have done preeminently and done very well at is sticking with some of the very basic research and a lot of stuff that has flowed out from that, which is of tremendous benefit, that I would hate to see us think that we are actually going to get the labs just working for private industry.

I do not believe any of you went that far, of course, but I would not want to let this pass without putting that one note of caution to it here.

One of the things with this advanced civilian technology agency that I had proposed that is not in the bill was that it be one of these interfaces with the very basic research going on at the labs, which is superb, best in the world, admired, and I have supported the labs in whatever request they have ever had, I think, just about.

But this was going to be the interface that kept track of all those things, and then kept the contacts with business going and worked out the arrangements and it would not have to be necessarily up to the labs and get the labs off of their primary mission, which is the very fundamental basic research.

If we lost that basic research objective, it seems to me we have lost something very valuable.

Dr. Yonas, you wanted to say something.

Dr. Yonas. Senator Glenn, with all due respect, at least in my opinion, the laboratories are not preeminent to basic research. They do primarily applied research.

Basic research is carried out in the universities of this country, and creating new knowledge is really not the province of the labs.

They more than likely, in almost every case, take basic research and apply it to fairly well defined problems.

Senator Glenn. Is that true of SDI?

Dr. Yonas. SDI is primarily an engineering problem and it is applying a considerable body of existing knowledge to a specific mission.

Senator Glenn. At least the people I have talked to at the labs, and I felt they were doing very basic research with regard to particle beam and lasers and so on.

Dr. Yonas. We may have a definition problem in terms of what we mean by creating new knowledge, but the issue at hand, I think, is this free and rapid flow of information and also protecting our national security interests, where we have a dilemma, we have the problem of how to protect information and still put the information where it is supposed to be.

In my view, the way to do that is—I think the best statement I heard is that technology transfer is a body-contact sport. It is with people working together in a way that can transfer knowledge, not widgets.

Senator Glenn. Any of the rest of you want to comment?

Dr. Cramer. Yes, Senator. I would like to comment on that. Part of the reason I make the distinction between basic types of technology and their appropriateness for transfer. I certainly would not propose that the laboratories promote the wholesale distribution of their R&D products in their main line business.

You mentioned that the spin-offs occur. Well, I think the labs have had a history of not having many spin-offs into the commercial sector. So one of the problems, I think, is that the ingredients are not in place for that to happen.

I think NASA has a fairly good record of that, but I do not have statistics at hand. The point that I would make is that the ingredients are not there for those spin-offs, to occur, and that is what we are really addressing here and trying to put in place.

Senator Glenn. I do not know how the NASA example is working right now, but some years ago when I was familiar with that they tried, really tried to take all the new information on materials development, processes, new accelerometers and all these things and make all that information available.

They had information centers and business people could sign in for so many queries a year of the whole data bank, and I went out when they opened one that happened to be at the University of Indiana back some years ago, and I do not even know whether it is still there or not.

It was a real effort to take the basic things that they were doing, where there were new things being discovered, and so on, and really make them available to everybody on a quite open basis, and maybe we need something like that set up for the national labs. I don't know.

Maybe that would be helpful, rather than leave each lab just on its own to do its own thing.

Senator **Bingaman**. Senator Domenici.

Senator **Domenici**. Mr. Chairman, I want to thank the witnesses. I though they were very provocative, and I greatly appreciate it.

Your notion and most apropos statement was technology transfer is a people-contact sport is absolutely correct. She made it and you affirmed it.

The problem we have is the national laboratories, for real or otherwise, are perceived to be marketplace unfriendly. There are not enough small, large, medium size or otherwise type people who are willing to make contact in this sport, there is some reason that they are not.

That is what we have been talking about today. They are not going onto a sporting field and make contact if there is not something in it for them.

What we have done with the maze of problems that have been discussed by this group and the previous group is we have made the people-contact sport very unproductive for academia with its relationships and the private sector with its relationships.

We are not trying to change the labs into a private sector operated entity. We are suggesting that they have significant knowledge and technology that is not going to be used in a synergistic way with the others unless we change our way of doing business, and I am hopeful that we will.

Senator Glenn, I want to ask you to do me a personal favor. I have a bill that is not the creature of the generic problem that we are discussing here. It addresses superconducting research because of its importance and because of strong programs throughout these labs. It also emphasizes genome sequencing and mapping, because Los Alamos happens to have the genome bank, and the importance of this subject to NIH and the private sector. Because of the importance of semiconductors to the economic health of the United States and the capabilities of the labs in that area semiconductor research and development is included in my bill.

As I did that, I found that you could not help but address these issues, and I have now modified it, after 2 days of hearings, Jeff was there, after 2 weeks of DOE beating up on us, saying they would not accept this, they could not accept that, they would not buy this, they would not give up their autonomy here, and now it is Senate bill 1480, as amended, with about 20 amendments that came from everybody under the sun.

Almost every issue here is now in that Senate bill S. 1480, as amended.

But I now address you as chairman of Government Affairs Committee. I would ask you to look at S. 1480 because of the problems that we have run into. Jeff and I as well as the Government Affairs Committee and the Judiciary Committee have studied it, and believe it or not, we had Howard Metzenbaum sign off on our bill without any hearing, so we have made some tremendous headway.

We got tied up in the waning moments of the bill, the trade bill, and it may be lucky that we did because it may never pass anyway.

But I would ask if you would look at it from the standpoint of addressing these issues, because we as New Mexico Senators have been going through this time after time about relating to the universities, exchange of students, sabbaticals, patent rights, who can enter into contracts, why will the private sector want to enter into contracts, and I am not talking about taking over but finding the area of expertise and saying, can you help us, and that is too hard to do.

I truly believe we know the issues.

I want to say to Dr. Yonas, I am not sure of one thing, I am not sure—I have come to the conclusion that cultural change, user friendliness, we ought to move that, but I am not sure about people, not that we do not have the greatest around, but frankly, no matter what we put in the statutes, we need real innovators trying to put together the arrangements.

We have the brightest people around, but when you try to marry them up and they come from the private sector, or academia, or they spent their whole life in the national laboratories, the problem is even with the statutes giving everybody new prerogatives, we really need the people innovators to put the new arrangements together.

In closing, I want to thank Sig Hecker. I think with a 3-month challenge, and that is about all you were given in that pilot project on superconducters, I think you will send the Secretary of Energy some exciting concepts for the national labs to be involved.

I think you have been very helpful, as part of your mission, putting that together, and I think a number of American companies are exhibiting a lot of interest.

Sandia Corporation went to SEMATECH saying this is a rare opportunity to involve the labs with the private sector in a whole new idea, new idea of a private-public company, and they said we have some assets and talent to contribute.

So I think we are making some headway. I do want to say, in conclusion, that while I may have said some very negative things about the Department of Energy in the past, and even some here today, I do believe they are beginning to understand that they have a rare treasure and that they ought to get off the dime and move in the direction of maximum utilization.

I think SEMATECH is an example, I think the pilot program there is an example, and there are some others that they are beginning to understand how strong a contribution they could make.

So I think it has been very useful and I thank you, Senator Bingaman, Mr. Chairman, for calling the hearing. I hope sooner or later we will devise some new legislation that will set the labs free, but if not, I think you are going to have to start doing it by hook or crook with innovative manpower and people power and that may even work without statute changes.

Thank you very much.

Senator **Bingaman**. Let me thank Senator Domenici and Senator Glenn and all the witnesses again, and those of you who have come out to listen today and help with putting on this hearing. I think it has been very useful and we have heard some good suggestions which I hope we can follow up with legislation.

Do you have any final statement, Senator?

Senator **Glenn**. No, none at all.

I want to congratulate you for having this hearing. This has been excellent testimony today. It has been a long afternoon, but very informative, too.

During the break, Jeff remarked that it is rare that we all really sit and listen like this. [Laughter.]

And it is, that is true, because in Washington we all have the office calling somebody and there is another meeting, so you run in, you have all testified, most of you that testified are not unique to testifying before Congress, this is not a unique time for you, and we are out to other things.

This has been very informative. It has been very good to sit and listen to all of you. You obviously put a lot of thought into your proposals, and I do not want my previous remarks being misinterpreted, either.

I want to move technology along as fast as we possibly can move it, and it is up to us to work out that modus operandi, whatever it turns out to be. Whether it is a university or whether it is a national lab, it just does not move on out. Yet we see Japan moving rapidly.

We are still talking some 10 months later, 11 months later, about how we may do this or may not do this. The Japanese are organized right now to go after it and move this technology into commonplace use if it comes along fast enough to do that.

We are still talking about how to get organized here. So this is one example where we are beginning to be out-competed by certain people around the world.

We were preeminent in everything technical and everything scientific for so long, I think we got a little complacent, and now we are being out-competed. We see other nations beginning with their more disposal national income now, which they did not have in the 40 years following World War II, but they are up there now and they are doing the things in education, they are doing the things in research because they have seen what the goose was that laid the golden egg in this country and they are beginning to copy our pattern.

So be warned, I think, and that is the reason the act that I proposed and some things like that were attempts to perhaps move technology up from university to user, or from labs to user, or from labs to university to labs or vice versa.

In other words, get the information out that is not security material, that is not so classified that we cannot get it out. But where we can, where there are spin-offs from all of this research that we can make use of, let us get with it and move it—whatever our method is, that is what we want to do.

So I appreciate you all being here. I thought it was excellent testimony. I know of Jeff's personal interest in this, having worked with him on the committee. I want to congratulate him on his efforts on competitiveness, and for putting this hearing together. I think you did a good job.

[Additional material submitted for the hearing record follows:]

U.S. SENATE,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Washington, DC, December 2, 1987.

Hon. SAM NUNN,
Chairman, Armed Services Committee, U.S. Senate, Washington, DC.

DEAR MR. CHAIRMAN: In July, I introduced S. 1480, the Department of Energy National Laboratories Cooperative Research Initiatives Act, and proposed amendments. This legislation is intended to better integrate university and private industry with the national lab system so as to speed the development of technologies such as superconductivity, semiconductor research and mapping the human genome. The Subcommittee on Energy Research and Development held two days of hearings on S. 1480 and the proposed amendments in September and have placed it on the Committee calendar for markup.

Your Committee held a hearing in Albuquerque on November 7 which provided excellent testimony for improved integration of the national labs, university research entities and the private sector. It appears that our two Committees are heading in the same direction concerning the mission of the national labs. Therefore, I request that attached summary of the Energy Committee legislation be included in the final committee print of the November 7 hearing held by your Subcommittee on Defense Industry and Technology. If you have any questions concerning this request, please contact Teri Curtin at 224-7572.

Thank you for your support and assistance in this matter.

Sincerely,

PETER V. DOMENICI,
U.S. Senator.

NATIONAL LABORATORY COOPERATIVE RESEARCH INITIATIVES ACT

SENATE BILL 1480

GENERAL FINDINGS:

- The Department of Energy has nine multiprogram National Laboratories with missions that include general science, energy science, and defense-related technology development.
- These Laboratories have large and complex "user facilities", uncomparable research equipment, unparalleled computer facilities, and excellent research and support staffs.
- While each Laboratory has a technology transfer program, the results have only been modest because private industry has not been sufficiently involved with the Laboratories.
- A new national initiative is needed to increase the flow of technology from these laboratories to the private sector.
- The goal of this new initiative would be to link the nation's capabilities for generating scientific and technological innovations to its capabilities for commercial activities.

GENERAL PURPOSES:

- To better integrate university and private industry into the National Laboratory system of the Department of Energy so as to speed the development of technology in areas of significant economic potential.

U.S. Industry and DOE Laboratory Centers for Research on Enabling Technologies for High-Temperature Superconducting Applications

FINDINGS:

- Recent developments in high-temperature superconducting materials hold great promise for highly efficient energy storage and transmission, medical diagnostics, magnets for physics research and fusion reactors, and smaller supercomputers.
- The United States is a world leader in basic research on high-temperature superconducting materials and programs supporting this research at the National Science Foundation and the Department of Energy should be maintained and strengthened.
- International interest in the commercialization of high-temperature superconducting materials is high and the key to success lies in the rapid development of these materials and the identification of applications.
- The Department of Energy's Laboratories have demonstrated expertise in superconductivity research and a proven record in research in enabling technologies which can benefit industrial efforts in product development.

PURPOSE:

- To research critical enabling technologies to assist U.S. industry in the commercialization of high-temperature superconductors.
- To provide national organization and coordination in the research, development, and commercialization of high-temperature superconductors.
- To encourage private industry, university, and Department of Energy Laboratory interaction through Centers for Research on Enabling Technologies at the Laboratories.

FORMATION OF COUNCIL AND CENTERS FOR RESEARCH ON ENABLING TECHNOLOGIES:

- The Secretary of Energy is authorized and directed to form a Council comprised of representatives of appropriate government agencies, universities and industry to provide guidance in setting goals and strategies for the timely research on critical enabling technologies in high-temperature superconductors. The Council should also set guidelines for the release of technical findings and developments.
- The Secretary of Energy is authorized and directed to establish cooperative research centers in enabling technology for superconducting materials and applications at National Laboratories with appropriate university and private industry participants.
- Centers should be located at Laboratories which demonstrate expertise in superconductivity research and research in associated technologies (e.g. thin film and bulk ceramic synthesis and processing; characterization of physical, chemical, and structural properties in materials).

TECHNOLOGY TRANSFER:

- General objective: Provide intellectual property tools to the contractors operating the Department of Energy's National Laboratories in order to ensure that the fruits of the enabling technologies in high-temperature superconductors research flow exclusively to United States industry.
- Apply the appropriate and beneficial provisions of 35 USC 200 et seq. to all Laboratory contractors.

  Current law: Gives universities, non-profits and small, for profit business contractors for federally funded research and development work the right to elect title to inventions, subject to a nonexclusive, paid-up license to the Government.

Reason for change: Several of the largest DOE laboratories, including Sandia and Oak Ridge, are operated by large for-profit contractors; participation of these labs is key to the success of this research initiative.

- Apply the appropriate and beneficial provisions of 35 USC 200 et seq. to the Department of Energy Government-Owned Contractor-Operated (GOCO) facilities primarily dedicated to weapons related and naval nuclear propulsion programs.

  Current law: Gives eligible contractors the right to elect title to inventions, subject to a nonexclusive, paid-up license to the Government. The current law excludes, however, inventions arising under DOE weapons related and naval nuclear propulsion programs at GOCO facilities primarily dedicated to those programs.

  Reason for change: Several of the largest DOE laboratories, including Lawrence Livermore, Los Alamos, Sandia and Oak Ridge, have facilities primarily dedicated to weapons related (and naval nuclear propulsion) programs of DOE. Technology arising under these programs will be a key to meeting the objectives of this research initiative.

- Broaden the provisions of Section 35 USC 200 to include not only patents but all intellectual property such as trade secrets, trademarks, copyrights and mask works.

  Current law: Applies only to patents. Other intellectual property tools, however, are needed to confer the benefits of this research initiative exclusively on U.S. industry.

  Reason for change: Valuable technical information arises in a variety of forms, each requiring different tools for protection. Trade secrets, for example, protect know-how; Copyright, as well as patents, protects software; Trademarks protect the identification of the source of products and services.

- Give Secretary of Energy discretion to waive the rights reserved where to do so would better promote the objectives of this research initiative.

  Current law: 35 USC 202(c)(4) reserves to the Government a license to use inventions in which the contractor has elected title.

  Reason for change: This is a new concept intended to encourage private industry to develop products that only the government would purchase. Technical advances made at DOE laboratories may require further development to bring the advances to the point of commercialization. It is often advantageous from the Government viewpoint to call upon private risk capital to perform the requisite development and marketing. Without intellectual property protections, however, a competitor may reap rewards attributable a market pioneer without commensurate investment. In some cases, the government's reserve license may be a disincentive to private industry to develop products and services which primarily address a government market. The reserve license, rather than saving the government the cost of royalties, may end up depriving the government of new products and services. (Note that under 28 USC 1498, the Government may authorize a competitor to use a patented invention, leaving the patent holder an action for reasonable compensation.)

- Allow each DOE contractor participating in this research initiative to enter into collaborative agreements in an amount up to $10 million on behalf of DOE with semiconductor consortia or U.S. firms in accordance with the objectives of this Act without approval from any Federal Agency.

  Current law: Approval is a long and often cumbersome process.

  Reason for change: Since Congress is recognizing the importance of this research initiative, it is consistent to provide the most expeditious method of approving Laboratory participation. Allowing the Laboratories to enter into the collaborative agreements is intended to streamline the process and make it responsive to industry needs.

- Require the contractors taking title to licenses under this Act to expeditiously further license out the technology to private U.S. industry. This section should be patterned after the March in Rights contained in 35 USC 203.

- Require the Secretary of Energy, in renegotiating the operating contracts with its laboratory contractors, to use its best efforts to include provisions which will facilitate to the maximum extent possible timely and efficient technology transfer from the contractors to private U.S. industry.

- Any royalty income earned as a result of intellectual property developed under this research initiative shall be used at the National Laboratory for furthering the objectives of this Act, subject to the sunset provision set forth below.

  - Each funding agreement for the operation of a DOE National Laboratory participating in the Department's superconductivity research initiative shall contain appropriate provisions to effectuate the following:

  - Laboratories may incur costs to obtain intellectual property rights in furtherance of the Act.

  - Require that any royalties or income earned in respect to subject intellectual property be used to defray the costs of procuring intellectual property protections, payments to authors and inventors, and to support scientific research, development and education at the facility; and

  - Require that the management of the intellectual property, including procurement and licensing, shall be administered by contractor employees on location at the facility instead of in Washington.

  Current law: 35 USC 202(c)(7)(C) and (E) are similar to the proposed section, however, current law only applies to the non-profit and small business contractors and excludes facilities primarily dedicated to weapons related and naval nuclear propulsion programs of DOE.

Reason for change: These provisions for the purposes of the superconductivity research initiative need to be expanded to cover all national laboratories participating in this research initiative, therefore, Government-Owned, Contractor-Operated labs should be included in these "Bayh-Dole" provisions. There is no reason to exclude them.

- o Provide that in 10 years or when the objectives of this program are achieved, whichever occurs first, any royalties that previously went to the contractor to further the superconductivity program, would then go into general revenues of the federal government instead.

- o This Act shall take precedence over any other Act which would require a disposition of rights in intellectual property or treatment of collaborative agreements in a manner inconsistent with this Act, including but not necessarily limited to section 152 of the Atomic Energy Act of 1954 (42 USC 2182) and Section 9 of the Federal yonnuclear Energy Research and Development Act of 1974 (42 USC 5901)

- o Nothing in this section shall be construed to limit the DOE National Laboratories from performing other human genome related research and development arranged for, or approved by the Secretary of Energy of his delegate. In such activities under this subsection, the Secretary of Energy is authorized to seek reimbursement from non-governmental funds such portion of the laboratories' cost as the Secretary determines to be appropriate.

- o Provide that although DOE may promulgate regulations, the law shall apply immediately.

COST SHARING:

- o The Secretary is authorized and directed to seek cost sharing in the establishment of the Centers for Enabling Technology.

INDUSTRY/NATIONAL LABORATORY PERSONNEL INTERCHANGE:

- o Visitations must be an important part of this program if it is to succeed, therefore, personnel from both the Laboratories and industry may participate in temporary assignments. U.S. industry personnel may have temporary assignments at the National Laboratories; and likewise, Laboratory personnel may have assignments with private industry on a rotating basis in order to maximize the exchange of knowledge. However, this activity should be carried out so as not to jeopardize security at the National Laboratories.

INTERNAL REVENUE CODE CONSIDERATIONS:

- o Provide that cost sharing funds of private industry qualify for research and development tax credit.y

Semiconductor Manufacturing Excellence Initiative

Sematech

FINDINGS:

- Semiconductors and related microelectronic devices are key components in computers, telecommunications, advanced defense systems and other equipment which together represent $230 billion in annual sales;
- The leadership position of this country in high technology areas is threatened by the changing nature of foreign competition, which is often strongly supported by the national governments involved;
- The United States Semiconductor industry leads all other principal U.S. industries in terms of its investment in research and development. The U.S. reinvested eighty-three percent of pretax profits however, this has been insufficient by worldwide standards;
- Technological superiority is a vital battlefield advantage for United States military forces;
- The critical role of electronics to our national defense is evidenced by the fact that the Department of Defense expends thirty-five percent of its research, development and procurement funds on electronics research;
- A principal factor responsible for the relative shift in strength of the U.S. and its semiconductor competitors is the fact that the major competitor established a strategic, long term goal of world superiority in semiconductor research and manufacturing technology.
- It is in the interests of the national security and national economy of the United States to create a partnership between private industry and the federal government to improve semiconductor manufacturing technology and to facilitate practical deployment of such technology in order to regain the United States' traditional world leadership in the field of semiconductors;
- Priority should be given to the development, demonstration and advancement of the semiconductor technology base in order to meet the needs of our Defense Department and to insure the continued vitality of a commercial manufacturing base;
- The Department of Defense is supporting the formation of Sematech to provide a national focus in assuring the vitality of the U.S. semiconductor industry in view of that industry's importance to national secuirty. The Department of Energy's National Laboratories can provide essential support for this effort.

  The Department of Energy's National Laboratories have large and complex "user facilities," uncomparable research equipment, unparalleled computer facilities, and excellent research and suppport staffs in the area of semiconductor technology.

- It is in the national interest to ensure that the rights in intellectual property be used to commercialize this new technology rapidly and effectively by the U.S. semiconductor industry;
- Interaction between industry and government in order to achieve program consensus is extremely important for the success of this initiative.
- To facilitate an exchange of knowledge, certain National Laboratory personnal may be temporarily assigned to Sematech and U.S. industry personnel may be temporarily assigned to the National Laboratories.

PURPOSE:

- To establish and conduct a cooperative government/industry program of research on semiconductor manufacturing technology and on the practical applications of such technology. And to apply effectively the unique capabilities of the Department of Energy's National Laboratories in this effort.

ROLE OF DEPARTMENT OF DEFENSE:

- Instruct the Secretary of Defense to establish and conduct a cooperative government/industry program of research on semiconductor manufacturing technology and on the practical applications of such technology.
- Instruct the Secretary of Defense to consult, advise and coordinate with the Secretary of Energy and other departments as the Secretary of Defense deems appropriate.

ROLE OF THE DEPARTMENT OF ENERGY'S NATIONAL LABORATORIES:

- Provide that it is a compatible and essential part of the Department of Energy, and hence the National Laboratories' mission, to participate in research and development projects in advanced semiconductor manufacturing techniques in conjunction with the Department of Defense, Department of Commerce, private consortia such as Sematech, universities and others.
- Instruct the Secretary of Energy to enter into agreements with Department of Defense, industry consortia such as Sematech and universities working with Sematech to use the National Laboratories' expertise to assist in the research and development of advanced semiconductor technology.
- Instruct the Secretary of Energy to include in his annual planning for the Research and Development budget such work as to encourage development of new technology in semiconductors.
- Authorize an additional $25 million for additional research and development in this area; to accelerate and compliment ongoing research and to work in conjunction with U.S. industry in areas which are essential to manufacturing success.

- Instruct the Secretary of Defense to consult, advise, and coordinate with the Secretary of Energy and other heads of appropriate government agencies to insure that the resources existing at the National Laboratories are used to enhance the semiconductor manufacturing technology program and to avoid duplication.

WORK PROGRAM FOR SEMATECH:

- Should follow the Sematech business plan. Areas to be developed in cooperation with U.S. industry should include research and development in such areas as advanced semiconductor manufacturing techniques, including sub-micron lithography, deposition, advanced materials, etching, cleaning and epitaxy, silicon process integration; new compound semiconductors and devices that are the basis for optoelectronics and optical communications; Test and demonstrate these techniques on an actual production line; develop techniques for adapting the processes which are proven on the demonstration line to provide flexible manufacturing so that the techniques can be applied to the manufacture of a wide variety of other products; create an automated and computer integrated manufacturing pilot emphasizing flexibility and high-volume.

WORK PROGRAM FOR DOE NATIONAL LABORATORIES PARTICIPATING IN THE SEMICONDCUTOR INITIATIVE:

- Program should complement the Sematech work program.

- Research and development in silicon and compound semiconductors should be performed in cooperation with U.S. industry. Program should emphasize advanced semiconductor manufacturing technologies including: ultra clean processing, processing technology for ultra high density silicon circuits, and imporved compound semiconductors and devices. The program may further include materials fabrication, materials characterization, device design and modeling, working with industry to develop new processing equipment and related activities.

INTERAGENCY AND PRIVATE INDUSTRY ADVISORY COMMITTEE:

- This should be patterned after the the Governmental Affairs reported out Sematech board which would provide expertise on how to best utilize the National Laboratories. Members would include among others, Secretary of Defense, Secretary of Energy, lab personnel, semiconductor industry experts and university personnel as appropriate.

TECHNOLOGY TRANSFER:

- General objective: Provide intellectual property tools to the contractors operating the Department of Energy's National Laboratories in order to ensure that the fruits of the semiconductor initiative flow exclusively to United States industry.

- Apply the appropriate and beneficial provisions of the 35 USC 200 et seq. to all Laboratory contractors.

  Current law: Gives universities, non-profit and small, for profit business contractors for federally funded research and development work the right to elect title to inventions, subject to a nonexclusive, paid-up license to the Government.

Reason for change: Several of the largest DOE laboratories, including Sandia and Oak Ridge, are operated by large for-profit contractors; participation of these labs is key to the success of the semiconductor initiative.

- Apply the appropriate and beneficial provisions of 35 USC 200 et seq. to the Department of Energy Government-Owned Contractor-Operated (GOCO) facilities primarily dedicated to weapons related and naval nuclear propulsion programs.

  Current law: Gives eligible contractors the right to elect title to inventions, subject to a nonexclusive, paid-up license to the Government. The current law excludes, however, inventions arising under DOE weapons related and naval nuclear propulsion programs at GOCO facilities primarily dedicated to those programs.

  Reason for change: Several of the largest DOE laboratories, including Lawrence Livermore, Los Alamos, Sandia and Oak Ridge, have facilities primarily dedicated to weapons related (and naval nuclear propulsion) programs of DOE. Technology arising under these programs will be a key to meeting the objectives of the semiconductor initiative.

- Broaden the provisions of Section 35 USC 200 to include not only patents but all intellectual property such as trade secrets, trademarks, copyrights and mask works.

  Current law: Applies only to patents. Other intellectual property tools, however, are needed to confer the benefits of the semiconductor initiative exclusively on U.S. industry.

  Reason for change: Valuable technical information arises in a variety of forms, each requiring different tools for protection. Trade secrets, for example, protect know-how; Copyright, as well as patents, protects software. ;Mask works protect integrated circuit layouts. Trademarks protect the identification of the source of products and services.

- Give Secretary of Energy discretion to waive the rights reserved where to do so would better promote the objectives of the semiconductor initiative.

  Current law: 35 USC 202(c)(4) reserves to the Government a license to use inventions in which the contractor has elected title.

  Reason for change: This is a new concept intended to encourage private industry to develop products that only the government would purchase. Technical advances made at DOE laboratories may require further development to bring the advances to the point of commercialization. It is often advantageous from the Government viewpoint to call upon private risk capital to perform the requisite development and marketing. Without intellectual property protections, however, a competitor may reap rewards attributable a market pioneer without commensurate investment. In some cases, the government's reserve license may be a disincentive to private industry to develop products and services which primarily address a government market. The reserve license, rather than saving the government the cost of royalties, may end up depriving the government of new products and services. (Note that under 28 USC 1498, the Government may authorize a competitor to use a patented invention, leaving the patent holder an action for reasonable compensation.

o Allow each DOE contractor participating in the semiconductor program to enter into collaborative agreements in an amount up to $10 million on behalf of DOE with semiconductor consortia or U.S. firms in accordance with the objectives of this Act without approval from any Federal Agency.

Current law: Approval is a long and often cumbersome process.

Reason for change: Since Congress is recognizing the importance of the semiconductor initiative, it is consistent to provide the most expeditious method of approving Laboratory participation. Allowing the Laboratories to enter into the collaborative agreements is intended to streamline the process and make it responsive to industry needs.

o Require the contractors taking title to licenses under this Act to expeditiously further license out the technology to private industry consortia such as Sematech and other U.S. companies. This section should be patterned after the March in Rights contained in 35 USC 203.

o Require the Secretary of Energy, in renegotiating the operating contracts with its laboratory contractors, to use its best efforts to include provisions which will facilitate to the maximum extent possible timely and efficient technology transfer from the contractors to private U.S. industry.

o Any royalty income earned as a result of intellectual property developed under the semiconductor initiative shall be used at the National Laboratory for furthering the objectives of this Act, subject to the sunset provision set forth below.

* Each funding agreement for the operation of a DOE National Laboratory participating in the Department's semiconductor technology initiative shall contain appropriate provisions to effectuate the following:

* Laboratories may incur costs to obtain intellectual property rights in furtherance of the Act.

* Require that any royalties or income earned in respect to subject intellectual property be used to defray the costs of procuring intellectual property protections, payments to authors and inventors, and to support scientific research, development and education at the facility; and

* Require that the management of the intellectual property, including procurement and licensing, shall be administered by contractor employees on location at the facility instead of in Washington.

Current law: 35 USC 202(c)(7)(C) and (E) are similar to the proposed section, however, current law only applies to the non-profit and small business contractors and excludes facilities primarily dedicated to weapons related and naval nuclear propulsion programs of DOE.

Reason for change: These provisions for the purposes of the semiconductor initiative need to be expanded to cover all national laboratories participating in the semiconductor initiative, therefore, Government-Owned, Contractor-Operated labs should be included in these "Bayh-Dole" provisions. There is no reason to exclude them.

- Provide that in ten years, or when the objectives of the program are achieved, whichever occurs first, any royalties that previously went to the contractor to use at the National Laboratory to further the semiconductor program would go into general revenues of the federal government instead.
- This Act shall take precedence over any other Act which would require a disposition of rights in intellectual property or treatment of collaborative agreements in a manner inconsistent with this Act, including but not necessarily limited to section 152 of the Atomic Energy Act of 1954 (42 USC 2182) and Section 9 of the Federal yonnuclear Energy Research and Development Act of 1974 (42 USC 5901)
- Nothing in this section shall be construed to limit the DOE National Laboratories from performing other semiconductor technology related research and development arranged for, or approved by the Secretary of Energy of his delegate. In such activities under this subsection, the Secretary of Energy is authorized to seek reimbursement from non-governmental funds such portion of the laboratories' cost as the Secretary determines to be appropriate.
- Provide that although DOE may promulgate regulations, the law shall apply immediately.

COST SHARING:

- Require at least a 50% private industry cost sharing.

INDUSTRY/NATIONAL LABORATORY PERSONNEL INTERCHANGE:

- Visitations must be an important part of this program if it is to succeed, therefore, personnel from both the Laboratories and industry should participate in temporary assignments. U.S. industry personnel should have temporary assignments at the National Laboratories; and likewise, Laboratory personnel should have assignments at Sematech on a rotating basis in order to maximize the exchange of knowledge. However, this activity should be carried out so as not to jeopardize security at the National Laboratories.

INTERNAL REVENUE CODE CONSIDERATIONS:

- Provide tax-exempt status for Sematech.
- Provide that contributions to Sematech shall qualify for the R&D tax credit.
- Provide that there is no taxable event upon the transfer of technology from Sematech to the member companies.

ANTITRUST:

- Provide that all activities set forth in this Act undertaken by private industry shall be covered by the National Cooperative Research Act.
- Provide an expedited review for Sematech under the National Cooperative Research Act.

Mapping the Human Genome

FINDINGS:

- The major health and well being our our nation depends on the medical breakthroughs in hereditary diseases, cancer, cardiovascular disease and the aging process that will flow from mapping the human genome.
- The knowledge gained, as well as the countless applications will bring economic health and physical well-being to the nation that accomplishes this goal.
- It is a compatible and essential part of the Department of Energy's National Laboratories' mission to participate in research and development projects in mapping the human genome.
- The Secretary of Energy should augment and accelerate the ongoing genetic science research of the Department of Energy.

PURPOSES:

- To establish a National Policy Board to coordinate the activities of the various government agencies involved in genetic research relevant to the mapping of the human genome.
- To establish a consortium under the direction of the Secretary of Energy, made up of industry, university and other government agencies to insure that the knowledge and intellectual property resulting from cooperative research are widely disseminated among the U.S. companies so as to enhance applications.

CREATION OF THE NATIONAL POLICY BOARD:

- A National Policy Board on the Human Genome with the following functions is created:

  identify the components of a successful national human genome strategy

  develop research and development strategies, tactics, and plans whose execution will assure U.S. leadership in the genome area.

  Recommend appropriate actions that support the national strategy.

  Oversight of the Technical and Operational Board

- Membership of the National Policy Board:

  Secretary of Energy as Chairman, Director of National Institutes of Health, Secretary of Agriculture, Director of the Office of Science and Technology Policy, the Director of the National Science Foundation, a member of the Human Genome Consortium representing private industry, and a member of the Human Genome Consortium representing universities.

CREATION OF THE HUMAN GENOME CONSORTIUM:

- The Secretary of Energy shall create a consortium of university, private industry and appropriate government agencies to:

  Create a physical map of the human genome, consisting of a complete set of segments of the DNA, arranged in order.

  Integrate information derived from government efforts in gene mapping into private industry.

  Locate genes and other markers on the map.

  Produce and distribute DNA sequences and other materials needed by the research community.

  Develop automation and robotics techniques for large-scale DNA mapping sequencing.

  Establish computer facilities and develop computer data bases for the storage, retrieval and dissemination of DNA segments, mapping and sequence information.

- Technical and operational functions of the Consortium include:

  collection and analysis of information on the needs and capabilities of industry, the Federal Goverment and the scientific and research communities related to the human genome.

  collection and analysis of information on the needs and capabilities of industry, the Federal Government and the scientific and research communities related to the human genome.

  Analyze options, establish priorities, and recommend roles for participants in the national strategy

  determine technical areas where United States biological and pharmaceutical industries are deficient relative to international competition

  Begin immediately with technology workshops to define the technology road maps for the consortium

  Assign a start-up team to continue development

  Approve projects for funding

  monitor progress

  Report to members on the progress

Handle day to day operations of the consortium

Report to the National Policy Board

- Provide an expedited review for the Human Genome Consortium under the National Cooperative Research Act.

TECHNOLOGY TRANSFER:

- General objective: Provide intellectual property tools to the contractors operating the Department of Energy's National Laboratories in order to ensure that the fruits of the human genome mapping initiative flow exclusively to United States industry.

- Apply the appropriate and beneficial provisions of 35 USC 200 et seq. to all Laboratory contractors.

  Current law: Gives universities, non-profits and small, for profit business contractors for federally funded research and development work the right to elect title to inventions, subject to a nonexclusive, paid-up license to the Government.

  Reason for change: Several of the largest DOE laboratories, including Sandia and Oak Ridge, are operated by large for-profit contractors; participation of these labs is key to the success of the human genome initiative.

- Apply the appropriate and beneficial provisions of 35 USC 200 et seq. to the Department of Energy Government-Owned Contractor-Operated (GOCO) facilities primarily dedicated to weapons related and naval nuclear propulsion programs.

  Current law: Gives eligible contractors the right to elect title to inventions, subject to a nonexclusive, paid-up license to the Government. The current law excludes, however, inventions arising under DOE weapons related and naval nuclear propulsion programs at GOCO facilities primarily dedicated to those programs.

  Reason for change: Several of the largest DOE laboratories, including Lawrence Livermore, Los Alamos, Sandia and Oak Ridge, have facilities primarily dedicated to weapons related (and naval nuclear propulsion) programs of DOE. Technology arising under these programs will be a key to meeting the objectives of the genome initiative.

- Broaden the provisions of Section 35 USC 200 to include not only patents but all intellectual property such as trade secrets, trademarks, copyrights and mask works.

  Current law: Applies only to patents. Other intellectual property tools, however, are needed to confer the benefits of the genome initiative exclusively on U.S. industry.

  Reason for change: Valuable technical information arises in a variety of forms, each requiring different tools for protection. Trade secrets, for example, protect know-how; Copyright, as well as patents, protects software; Trademarks protect the identification of the source of products and services.

- o Give Secretary of Energy discretion to waive the rights reserved where to do so would better promote the objectives of the genome initiative.

  Current law: 35 USC 202(c)(4) reserves to the Government a license to use inventions in which the contractor has elected title.

  Reason for change: This is a new concept intended to encourage private industry to develop products that only the government would purchase. Technical advances made at DOE laboratories may require further development to bring the advances to the point of commercialization. It is often advantageous from the Government viewpoint to call upon private risk capital to perform the requisite development and marketing. Without intellectual property protections, however, a competitor may reap rewards attributable a market pioneer without commensurate investment. In some cases, the government's reserve license may be a disincentive to private industry to develop products and services which primarily address a government market. The reserve license, rather than saving the government the cost of royalties, may end up depriving the government of new products and services. (Note that under 28 USC 1498, the Government may authorize a competitor to use a patented invention, leaving the patent holder an action for reasonable compensation.)

- o Allow each DOE contractor participating in the genome initiative to enter into collaborative agreements in an amount up to $10 million on behalf of DOE with semiconductor consortia or U.S. firms in accordance with the objectives of this Act without approval from any Federal Agency.

  Current law: Approval is a long and often cumbersome process.

  Reason for change: Since Congress is recognizing the importance of the genome initiative, it is consistent to provide the most expeditious method of approving Laboratory participation. Allowing the Laboratories to enter into the collaborative agreements is intended to streamline the process and make it responsive to industry needs.

- o Require the contractors taking title to licenses under this Act to expeditiously further license out the technology to private industry consortia such as one one created under this Act and other U.S. companies. This section should be patterned after the March in Rights contained in 35 USC 203.

- o Require the Secretary of Energy, in renegotiating the operating contracts with its laboratory contractors, to use its best efforts to include provisions which will facilitate to the maximum extent possible timely and efficient technology transfer from the contractors to consortia and private U.S. industry.

- o Any royalty income earned as a result of intellectual property developed under the genome initiative shall be used at the National Laboratory to further the objectives of this Act subject to the sunset provision set forth below.

- Each funding agreement for the operation of a DOE National Laboratory participating in the Department's genome mapping initiative shall contain appropriate provisions to effectuate the following:

- Laboratories may incur costs to obtain intellectual property rights in furtherance of the Act.

- Require that any royalties or income earned in respect to subject intellectual property be used to defray the costs of procuring intellectual property protections, payments to authors and inventors, and to support scientific research, development and education at the facility; and

- Require that the management of the intellectual property, including procurement and licensing, shall be administered by contractor employees on location at the facility instead of in Washington.

  Current law: 35 USC 202(c)(7)(C) and (E) are similar to the proposed section, however, current law only applies to the non-profit and small business contractors and excludes facilities primarily dedicated to weapons related and naval nuclear propulsion programs of DOE.

  Reason for change: These provisions for the purposes of the genome initiative need to be expanded to cover all national laboratories participating in the genome initiative, therefore, Government-Owned, Contractor-Operated labs should be included in these "Bayh-Dole" provisions. There is no reason to exclude them.

- This Act shall take precedence over any other Act which would require a disposition of rights in intellectual property or treatment of collaborative agreements in a manner inconsistent with this Act, including but not necessarily limited to section 152 of the Atomic Energy Act of 1954 (42 USC 2182) and Section 9 of the Federal yonnuclear Energy Research and Development Act of 1974 (42 USC 5901)

- Nothing in this section shall be construed to limit the DOE National Laboratories from performing other human genome related research and development arranged for, or approved by the Secretary of Energy of his delegate. In such activities under this subsection, the Secretary of Energy is authorized to seek reimbursement from non-governmental funds such portion of the laboratories' cost as the Secretary determines to be appropriate.

- Provide that although DOE may promulgate regulations, the law shall apply immediately.

COST SHARING:

- Require at least a 50% private industry cost sharing.

INDUSTRY/NATIONAL LABORATORY PERSONNEL INTERCHANGE:

- Visitations must be an important part of this program if it is to succeed, therefore, personnel from both the Laboratories and industry may participate in temporary assignments. U.S. industry personnel may have temporary assignments at the National Laboratories on a rotating basis in order to maximize the exchange of knowledge. However, this activity should be carried out so as not to jeopardize security at the National Laboratories.

COST SHARING:

- Require private industry cost sharing.

INDUSTRY/NATIONAL LABORATORY PERSONNEL INTERCHANGE:*

- Visitations must be an important part of this program if it is to succeed, therefore, U.S. industry personnel should have temporary assignments at the National Laboratories; and likewise, Laboratory personnel should have assignments at Sematech on a rotating basis in order to maximize the exchange of knowledge.

INTERNAL REVENUE CODE CONSIDERATIONS:

- Provide tax-exempt status for the Humane Genome Consortium.
- Provide that contributions to the Human Genome Consortium shall qualify for the R&D tax credit.
- Provide that there is no taxable event upon the transfer of technology from the Human Genome Consortium to the member companies.

ANTITRUST:

- Provide an expedited review for the Human Genome Consortium under the National Cooperative Research Act.

INSTITUTE FOR ENTREPRENEURIAL STUDIES

FINDINGS:

- Science and Technology are critical to our our country's future especially since competitor nations are investing heavily to improving their capabilities in this area; if our nation is to remain in the competition, our government must make a capital investment to enhance its science and technology capabilities;
- Established companies and entrepreneurs can no longer keep pace with the rate technology is developing.
- Restoring our competitiveness requires a federal commitment to promote and foster research and entrepreneurial skills that will improve cooperative linkages between scientists, engineers and industry;
- The National Laboratories-Industry-University partnership is fundamental to meeting these goals of fostering entrepreneurial superiority that will lead to economic competitiveness;

- A new generation of entrepreneurs is needed to properly take advantage of today's dynamic environment of technological innovation

- Along with its specific areas of scientific research, the Department of Energy can contribute to economic competitiveness by establishing regional institutes of entrepreneurship charted as work study-programs.

PURPOSE:

To establish within existing universities, six regional Institutes for Entrepreneurial Studies chartered as work-study programs that would be affiliated with a Department of Energy National Laboratory.

ROLE OF DEPARTMENT OF ENERGY'S NATIONAL LABORATORIES:

Instruct the Secretary of Energy to create six regional Institutes for Entrepreneurial Studies, each with an association with one of the National Laboratories.

CRITERIA FOR SETTING UP THE INSTITUTES:

The quality of the research and development being carried out at the university ;

the degree of commericalization potential for such innovative research and development;

regional and geographic distribution of funds to insure Institutes throughout the States and regions of the country;

the economic stimulus to a State or region derived from the research and development;

PROGRAM AUTHORIZED:

From the funds appropriated to carry out this program, the Secretary of Energy shall make grants to institutions of Higher Education.

FORMATION OF THE GOVERNING BOARD:

The Secretary of Energy is authorized and directed to form a Governing Board of the Institutes of Entrepreneurial Studies comprised of representatives of appropriate government agencies, universities and industry.

PROGRAM:

- Each student would be expected to pursue a specific project during his/her course of study. The curriculum would include:

  Development and writing a business plan and Establishment of a corporate structure.

  Venture capital

  Management of technology, technologists and technological change

  International markets and competition

  Marketing and market reserve

Manufacturing

Licensing and intellectual property rights

Crisis Management

Ethics

Each student would work on a specific project with the assistance of a mentor in one of the National Laboratories or private industry.

A Masters Degree would be available, however, candidates need not be degree seeking students.

Senator BINGAMAN. Thank you all very much. We will conclude the hearing.

[Whereupon, at 5 p.m. the hearing was adjourned.]

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